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JEE (ADV) 886  
WBJEE 14



MITRANJAN KHAN  
JEE (ADV) 4323



ARITRA SAMANTA  
JEE (ADV) 5496  
WBJEE 94



ROSHNI SINGH  
JEE (ADV) 5516  
WBJEE 225



ANISH AGARWAL  
JEE (ADV) 8161  
WBJEE 173

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NEET AIR 216



NIRMAN MANDAL  
NEET AIR 897  
SR 18



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SR 133



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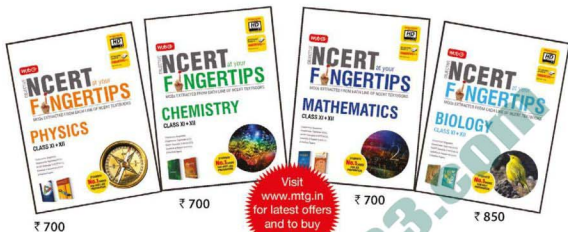
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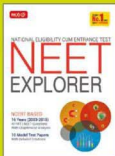
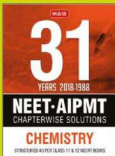
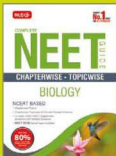


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# CHEMISTRY

# today

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# FOCUS

Class  
XI

# NEET/JEE 2019

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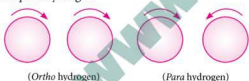
## UNIT - 5 : Hydrogen | The s-Block Elements

### HYDROGEN

- Hydrogen is the lightest element. It has the simplest electronic configuration,  $1s^1$ .
- Hydrogen resembles both alkali metals (loses one electron to form unipositive ion, form oxides, halides and sulphides) and halogens (forms diatomic molecule, hydrides and large number of covalent compounds).

#### ALLOTROPES OF HYDROGEN

- Two allotropes of hydrogen are *Ortho* hydrogen and *para* hydrogen.

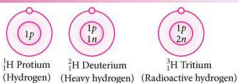


- At room temperature, ordinary hydrogen contains 75% *ortho*-hydrogen and 25% *para* hydrogen. As the temperature decreases, the percentage of

*ortho* hydrogen in the mixture decreases. Pure *para* hydrogen can be prepared by cooling nearly to absolute zero but pure *ortho* hydrogen cannot be prepared.

- Stability:** *Ortho* hydrogen > *Para* hydrogen
- Differences in physical properties of both is because of differences in internal energy of both. Internal energy of *ortho*  $H_2$  > *para*  $H_2$ .

#### ISOTOPES OF HYDROGEN

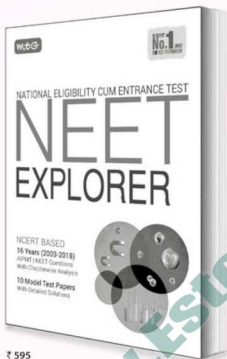


- Molecular forms:**  $^1\text{H}_2$  (dihydrogen)  $^2\text{H}_2$  or  $\text{D}_2$  (dideuterium);  $^3\text{H}_2$  or  $\text{T}_2$  (ditritium) alongwith HD, HT, DT, etc.

Name	Symbol	Atomic mass	<i>p</i>	<i>n</i>	Abundance %	Nuclear stability	Nuclear spin quantum number	Relative atomic mass
Protium	$^1_1\text{H}(\text{H})$	1	1	0	99.986	Stable	1/2	1.007825
Deuterium	$^2_1\text{H}(\text{D})$	2	1	1	0.014	Stable	1	2.014102
Tritium	$^3_1\text{H}(\text{T})$	3	1	2	$7 \times 10^{-16}$	Radioactive	1/2	3.106049

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## PREPARATION OF HYDROGEN

From water  
with metals



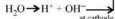
with ionic hydrides



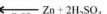
with methane



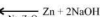
electrolysis



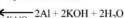
From acids



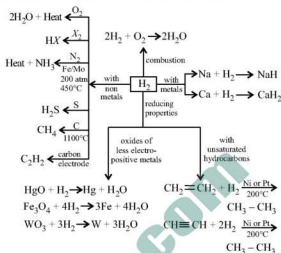
From alkalis



Uyeno's method



## CHEMICAL PROPERTIES OF HYDROGEN



## HYDRIDES

Hydrogen forms binary hydrides with elements of *s*, *p*, (except noble gases), *d* and *f*-block.

### Ionic or Saline Hydrides

- Group-1,2 elements form ionic hydrides, e.g., NaH, CaH<sub>2</sub>, CsH, SrH<sub>2</sub> etc. except Be and Mg. BeH<sub>2</sub>, MgH<sub>2</sub> have slightly covalent polymeric structure.
- They are powerful reducing agents, especially at high temperatures.
- LiH and NaH have been used in synthesis of other useful hydrides.



### Metallic or Interstitial Hydrides

- d* and *f*-block elements form metallic hydrides. These are non-stoichiometric, being deficient in hydrogen, e.g., LaH<sub>2.87</sub>, YbH<sub>2.55</sub>, etc.
- Metals of group-7, 8, 9 do not form hydrides and this region of periodic table is referred as hydride gap.
- Metallic hydrides can be used as hydrogen storage media.

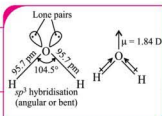
### Covalent or Molecular Hydrides

- p*-Block elements form molecular or covalent hydrides. These are usually volatile compounds with low m.p.t. and b.p.t. These are of three types :
  - Electron-deficient hydrides** : Formed by group-13 elements, e.g., B<sub>2</sub>H<sub>6</sub>, (AlH<sub>3</sub>)<sub>n</sub> etc.
  - Electron-precise hydrides** : Formed by group-14 elements, e.g., CH<sub>4</sub>, SiH<sub>4</sub>, etc.
  - Electron-rich hydrides** : Formed by group-15, 16 and 17 elements, e.g., NH<sub>3</sub>, H<sub>2</sub>O, HCl, etc.

## WATER, H<sub>2</sub>O

Colourless, odourless and tasteless liquid, gives bluish tinge in thick layers.

Plays a key role in the biosphere due to its high specific heat, thermal conductivity, surface tension, dipole moment and dielectric constant, etc.



Extensive hydrogen bonding leads to high freezing point, high boiling point, high heat of vaporisation and high heat of fusion in comparison to H<sub>2</sub>S and H<sub>2</sub>Se.

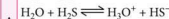
Water has maximum density at 277 K as above this temperature, the increase in volume due to expansion of liquid water is much more than the decrease in volume due to breaking of H-bonds.

### Chemical Properties

#### W Amphoteric nature



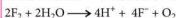
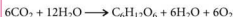
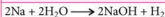
Acid      Base



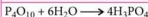
Base      Acid

However, water is neutral towards litmus and its pH is 7.

#### Redox reactions



#### Hydrolysis reactions



#### Hydrate formation

Coordinated water :  $[\text{Cr}(\text{H}_2\text{O})_6]^{3+} 3\text{Cl}^-$

Interstitial water :  $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$

Hydrogen-bonded water :  $[\text{Cu}(\text{H}_2\text{O})_4]^{2+} \text{SO}_4^{2-} \cdot \text{H}_2\text{O}$  in  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$

(Only one H<sub>2</sub>O which is outside the coordination sphere is hydrogen bonded, other four are coordinated.)

### Hard and Soft Water

Depending upon its behaviour towards soap solution water may be classified as soft water and hard water.

- **Soft Water** : Water that produces lather with soap readily is called soft water. e.g., rain water, distilled water.
- **Hard Water** : Water which does not produce lather with soap readily is called hard water. e.g., sea water, river water.

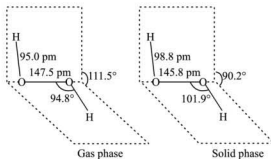
### Hardness of Water

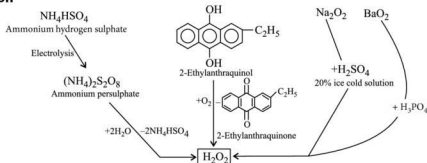
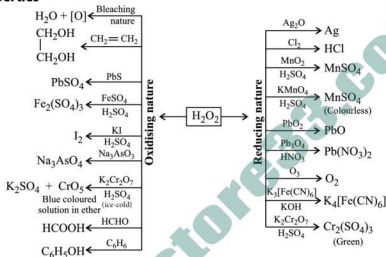
Temporary hardness	Permanent hardness
It is due to the presence of bicarbonates of calcium and magnesium.	It is due to the presence of soluble chlorides and sulphates of calcium and magnesium.
It can be easily removed by boiling or by Clark's process (using quick lime).	It can be removed by special methods like washing soda method, ion-exchange method and Calgon's process.

### HYDROGEN PEROXIDE, H<sub>2</sub>O<sub>2</sub>

- Pure H<sub>2</sub>O<sub>2</sub> is an almost colourless, odourless, bitter taste liquid but gives a bluish tinge in thick layers.
- H<sub>2</sub>O<sub>2</sub> is miscible in water in all proportions and forms a hydrate H<sub>2</sub>O<sub>2</sub>·H<sub>2</sub>O.
- The dipole moment of H<sub>2</sub>O<sub>2</sub> is little more (2.1 D) than that of H<sub>2</sub>O (1.84 D).

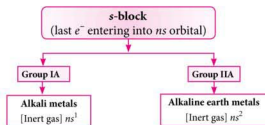
### Structure of H<sub>2</sub>O<sub>2</sub>



**Preparation****Chemical Properties****Strength of  $\text{H}_2\text{O}_2$  Solution**

- Volume strength =  $5.6 \times \text{Normality}$
- $$= 5.6 \times \frac{\text{Percentage strength}}{\text{Eq.wt of } \text{H}_2\text{O}_2 \text{ (i.e., 17)}} \times 10$$
- $$= 5.6 \times \frac{\text{Strength in gL}^{-1}}{\text{Eq.wt of } \text{H}_2\text{O}_2 \text{ (i.e., 17)}}$$

- Volume strength =  $11.2 \times \text{Molarity}$
- $$= 11.2 \times \frac{\text{Percentage strength}}{\text{Mol.wt of } \text{H}_2\text{O}_2 \text{ (i.e., 34)}} \times 10$$
- $$= 5.6 \times \frac{\text{Strength in gL}^{-1}}{\text{Eq.wt of } \text{H}_2\text{O}_2 \text{ (i.e., 17)}}$$
- % strength = Volume strength  $\times 0.3035$

**THE s-BLOCK ELEMENTS****GROUP IA – ALKALI METALS**

- The group IA elements are known as alkali metals because hydroxides of these metals are soluble in water and their solution is alkaline in nature. Their valence shell electronic configuration is  $ns^1$ . Alkali metals are strongly reactive and lose their valence shell electron in order to attain nearest noble gas configuration.

### Gradation in Properties of Alkali Metals

Atomic radii	Li	M.P. and B.P.	Max.
Atomic volume	Na	Hardness	
Density	K	Ionisation energy	
Reactivity	Rb	Conductivity	
Reducing power	Cs	Electronegativity	
Electropositivity		Solubility of salts	
Anion stabilisation		having large anions	
Solubility of salts			
having small anions			

### Chemical Properties

Li	Reaction with water $M + H_2O \longrightarrow MOH + \frac{1}{2} H_2$
Na	Reaction with excess of oxygen $4Li + O_2 \longrightarrow 2Li_2O$ $2Na + O_2 \longrightarrow Na_2O_2$ $M + O_2 \longrightarrow MO_2$ ( $M = K, Rb, Cs$ )
K	Reaction with hydrogen $2M + H_2 \xrightarrow{673\text{ K}} 2MH$ $2Li + H_2 \xrightarrow{1073\text{ K}} 2LiH$
Rb	Reaction with group 15 elements $3M + P \longrightarrow M_3P$ $3M + As \longrightarrow M_3As$ $3M + Sb \longrightarrow M_3Sb$
Cs	Reaction with group 16 elements $2M + S \longrightarrow M_2S$ $2M + Se \longrightarrow M_2Se$ $2M + Te \longrightarrow M_2Te$
Fr	Reaction with halogens $2M + X_2 \longrightarrow 2MX$ ( $M = Li, Na, K, Rb, Cs$ ; $X = F, Cl, Br, I$ )
	Reaction with ammonia $M + (x+y) NH_3 \longrightarrow [M(NH_3)_x]^+ + [e(NH_3)_y]^-$ $M + NH_3 \longrightarrow MNH_2 + \frac{1}{2} H_2$

### Trends in alkali metals and their compounds

- **Electropositive character:**  $Li < Na < K < Rb < Cs$
- **Hydration enthalpy:**  $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$
- **Solubility and basic character:**  $LiOH < NaOH < KOH < RbOH < CsOH$
- **Reducing character:**  $Na < K < Rb < Cs < Li$
- **Stability of carbonates:**  $Li_2CO_3 < Na_2CO_3 < K_2CO_3 < Rb_2CO_3 < Cs_2CO_3$
- **Stability of bicarbonates:**  $NaHCO_3 < KHCO_3 < RbHCO_3 < CsHCO_3$

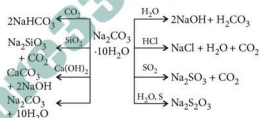
### Anomalous behaviour of Lithium

All alkali metals	Except
Do not react directly with $N_2$ or C.	$Li_3N$ or $Li_2C_2$
Form amide ( $MNH_2$ ) with ammonia.	$Li_2NH$
Nitrates are thermally stable.	$LiNO_3$
Carbonates are thermally stable.	$Li_2CO_3$
Form double salts (alums) from their sulphates.	$Li_2SO_4$
Form acetylides with acetylene.	Li

### Important Compounds of Sodium

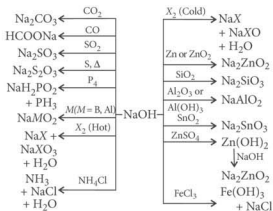
- **Sodium carbonate or Washing soda,  $Na_2CO_3 \cdot 10H_2O$**

Sodium carbonate is manufactured by Solvay process. In this process compounds used as raw materials are brine ( $NaCl$ ),  $NH_3$  and  $CaCO_3$ .



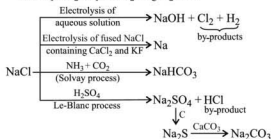
- **Sodium hydroxide or Caustic soda,  $NaOH$**

Sodium hydroxide is an important compound of chemical industry. This is prepared commercially by the electrolysis of an aqueous solution of sodium chloride using Castner-Kellner cell or Mercury cathode process.



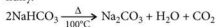
• **Sodium chloride or Table salt, NaCl**

Sodium chloride is found in abundance in sea water with an average concentration of 3%. NaCl obtained from sea water may have the impurities of  $\text{CaSO}_4$ ,  $\text{Na}_2\text{SO}_4$ ,  $\text{CaCl}_2$ ,  $\text{MgCl}_2$ , etc.



• **Sodium hydrogen carbonate or Baking soda,  $\text{NaHCO}_3$**

$\text{NaHCO}_3$  on heating decomposes to produce bubbles of  $\text{CO}_2$  which make the cakes and pastries fluffy.



It is amphiprotic i.e., it can act as  $\text{H}^+$  donor as well as  $\text{H}^+$  acceptor.



## GROUP IIA – ALKALINE EARTH METALS

The name 'alkaline earth' is given to group IIA elements because their oxides form alkaline solution with water (except Be).

### Gradation in Properties of Alkaline Earth Metals

Atomic radii	↑
Electropositivity	↑
Reducing power	↑
Stability of carbonates, hydroxides and sulphates	↑
Solubility and basic strength of oxides and hydroxides	↑
Solubility of halides	↑
Ionization enthalpy	↓
Electronegativity	↓
Hydration enthalpy	↓
Solubility of carbonates and bicarbonates	↓

### Chemical Properties

<b>Be</b>	<b>Reaction with water</b> $M + 2\text{H}_2\text{O} \longrightarrow M(\text{OH})_2 + \text{H}_2$ ( $M = \text{Ca, Sr, Ba}$ )
<b>Mg</b>	<b>Reaction with <math>\text{X}_2</math> or <math>\text{HX}</math></b> $M + \text{X}_2 \longrightarrow \text{MX}_2$ $M + 2\text{HX} \longrightarrow \text{MX}_2 + \text{H}_2$

<b>Ca</b>	<b>Reaction with oxygen</b> With quantitative amount of oxygen : $2M + \text{O}_2 \xrightarrow{\Delta} 2\text{MO}$ ( $M = \text{Be, Mg, Ca}$ ) With excess oxygen : $M + \text{O}_2 \longrightarrow \text{MO}_2$ ( $M = \text{Ra, Sr, Ba}$ )
<b>Sr</b>	<b>Reaction with hydrogen</b> $M + \text{H}_2 \xrightarrow{\Delta} \text{MH}_2$ ( $M = \text{Mg, Ca, Sr, Ba}$ )
<b>Ba</b>	<b>Reaction with group 15 elements</b> $3M + \text{N}_2 \xrightarrow{\Delta} \text{M}_3\text{N}_2$ $3M + 2\text{P} \longrightarrow \text{M}_3\text{P}_2$
<b>Ra</b>	<b>Reaction with group 16 elements</b> $M + \text{S} \longrightarrow \text{MS}$ $M + \text{Se} \longrightarrow \text{MSe}$ $M + \text{Te} \longrightarrow \text{MTe}$
	<b>Reaction with <math>\text{NH}_3</math></b> $M + (x + 2y)\text{NH}_3 \longrightarrow [\text{M}(\text{NH}_3)_x]^{2+} + 2[\text{e}(\text{NH}_3)_y]^-$ $M + 2\text{NH}_3 \longrightarrow \text{M}(\text{NH}_2)_2 + \text{H}_2$

### Trends in alkaline earth metals and their compounds

- **Hydration enthalpy :**  $\text{Be}^{2+} > \text{Mg}^{2+} > \text{Ca}^{2+} > \text{Sr}^{2+} > \text{Ba}^{2+}$
- **Reducing character :**  $\text{Be} < \text{Mg} < \text{Ca} < \text{Sr} < \text{Ba} < \text{Ra}$
- **Solubility, thermal stability and basic character of hydroxides :**  $\text{Mg}(\text{OH})_2 < \text{Ca}(\text{OH})_2 < \text{Sr}(\text{OH})_2 < \text{Ba}(\text{OH})_2$
- **Solubility of carbonates :**  $\text{BeCO}_3 > \text{MgCO}_3 > \text{CaCO}_3 > \text{SrCO}_3 > \text{BaCO}_3$
- **Stability and ionic character of carbonates :**  $\text{BeCO}_3 < \text{MgCO}_3 < \text{CaCO}_3 < \text{SrCO}_3 < \text{BaCO}_3$
- **Solubility of sulphates :**  $\text{BeSO}_4 > \text{MgSO}_4 > \text{CaSO}_4 > \text{SrSO}_4 > \text{BaSO}_4$   
Virtually insoluble

### Anomalous Properties of Beryllium

Property of Be	Properties of other alkaline earth metals
Forms covalent compounds	Form ionic compounds
Dissolves in alkalis $\text{Be} + 2\text{NaOH} + 2\text{H}_2\text{O} \longrightarrow \text{Na}_2\text{BeO}_2 + 2\text{H}_2 + \text{H}_2$	Does not react with alkalis.
Hydroxide of Be is covalent and amphoteric.	Hydroxides are ionic and basic in nature.



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8. An ionic compound is dissolved simultaneously in heavy water and simple water. Its solubility is  
(a) higher in heavy water  
(b) lower in heavy water  
(c) same in both  
(d) lower in simple water.
9. Which one of the following compounds on thermal decomposition yields a basic as well as an acidic oxide?  
(a)  $\text{KClO}_3$  (b)  $\text{CaCO}_3$   
(c)  $\text{NH}_4\text{NO}_3$  (d)  $\text{NaNO}_3$
10. Which of the following hydrides has polymeric structure?  
(a)  $\text{CaH}_2$  (b)  $\text{NaH}$  (c)  $\text{LiH}$  (d)  $\text{BeH}_2$
11. Pick out the statements(s) which is/are true about diagonal relationship of Li and Mg.  
(A) Polarising powers of  $\text{Li}^+$  and  $\text{Mg}^{2+}$  are very high.  
(B) Like Li, Mg decomposes water very fast.  
(C)  $\text{LiCl}$  and  $\text{MgCl}_2$  are deliquescent.  
(D) Like Li, Mg readily reacts with liquid bromine at ordinary temperature.  
(a) Only A and C (b) Only B and D  
(c) Only C (d) Only A
12. Which is poorest reducing agent?  
(a) Nascent hydrogen  
(b) Atomic hydrogen  
(c) Dihydrogen  
(d) All have same reducing strength
13. The main oxides formed on combustion of Li, Na and K in excess of air are respectively  
(a)  $\text{Li}_2\text{O}$ ,  $\text{Na}_2\text{O}$  and  $\text{KO}_2$   
(b)  $\text{Li}_2\text{O}$ ,  $\text{Na}_2\text{O}_2$  and  $\text{K}_2\text{O}$   
(c)  $\text{Li}_2\text{O}_2$ ,  $\text{Na}_2\text{O}_2$  and  $\text{KO}_2$   
(d)  $\text{Li}_2\text{O}$ ,  $\text{Na}_2\text{O}_2$  and  $\text{KO}_2$
14. Which of the following is the similar product of electrolysis of fused  $\text{NaCl}$  and electrolysis of aq.  $\text{NaCl}$ ?  
(a) Na (b)  $\text{NaOH}$   
(c)  $\text{Cl}_2$  (d)  $\text{H}_2$
15. Which statement is correct?  
(a)  $\text{H}_2\text{O}_2$  reduces  $\text{MnO}_4^-$  both in acidic and basic medium.  
(b)  $\text{H}_2\text{O}_2$  oxidised  $\text{Fe}^{2+}$  both in acidic and basic medium.  
(c)  $\text{H}_2\text{O}_2$  liberates  $\text{I}_2$  from acidified  $\text{KI}$  solution and reduces  $\text{I}_2$  to  $\text{I}^-$  ions in basic medium.  
(d) All of these.
16. Which of the following carbides produces propyne on reaction with water?  
(a)  $\text{CaC}_2$  (b)  $\text{Be}_2\text{C}$   
(c)  $\text{Al}_4\text{C}_3$  (d)  $\text{Mg}_2\text{C}_3$
17. Flame test is not given by  
(a) Be (b) K (c) Sr (d) Ca
18. For which of the following thermal stability decreases as we move down the group?  
(a) Hydrides of alkali metal  
(b) Carbonates of alkali metal  
(c) Sulphates of alkaline earth metal  
(d) None of these
19. When  $\text{SO}_3$  is treated with heavy water the product is/are  
(a) deuterium and sulphuric acid  
(b) deuterium and sulphurous acid  
(c) only deuterium  
(d) deuteriosulphuric acid.
20. A metal  $M$  readily forms its sulphate  $\text{MSO}_4$  which is water soluble. It forms its oxide  $\text{MO}$  which becomes inert on heating. It forms an insoluble hydroxide  $\text{M}(\text{OH})_2$  which is soluble in  $\text{NaOH}$  solution. Then  $M$  is  
(a) Mg (b) Ba (c) Ca (d) Be
21. A sample of hard water contains 20 mg of  $\text{Ca}^{2+}$  ions per litre. How many milliequivalents of  $\text{Na}_2\text{CO}_3$  would be required to soften 1 litre of the sample?  
(a) 0.1 (b) 1.0 (c) 1.5 (d) 0.15
22. Which of the following statements is false?  
(a)  $\text{BeCl}_2$  exists as a dimer in vapour state and polymeric in solid state.  
(b) Calcium hydride is called hydrolith.  
(c)  $\text{SrSO}_4$  is less soluble in water than  $\text{CaSO}_4$ .  
(d) Bicarbonates of Na and Sr are insoluble in water.
23. *Ortho*-hydrogen and *para*-hydrogen resemble in which of the following properties?  
(a) Thermal conductivity  
(b) Magnetic properties  
(c) Chemical properties  
(d) Heat capacity
24. Calgon used as a water softener is  
(a)  $\text{Na}_2[\text{Na}_4(\text{PO}_4)_5]$  (b)  $\text{Na}_4[\text{Na}_2(\text{PO}_3)_6]$   
(c)  $\text{Na}_2[\text{Na}_4(\text{PO}_3)_6]$  (d)  $\text{Na}_4[\text{Na}_4(\text{PO}_4)_6]$

25. In the following reactions, (X) and (Y) are respectively:



- (a)  $\text{Na}(\text{CN})_2$  and  $\text{Ca}(\text{CN})_2$   
 (b)  $\text{Ba}(\text{CN})_2$  and  $\text{CaCN}_2$   
 (c)  $\text{BaCN}_2$  and  $\text{CaCN}_2$   
 (d) None of these

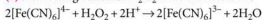
### SOLUTIONS

1. (b): The stronger base  $\text{H}^-$  will displace  $\text{OH}^-$  from water, hence, the reaction is

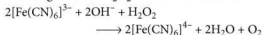


2. (c)

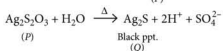
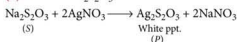
3. (c): Oxidising action of  $\text{H}_2\text{O}_2$  in acidic medium :



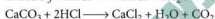
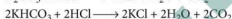
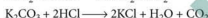
Reducing action of  $\text{H}_2\text{O}_2$  in alkaline medium :



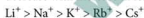
4. (b): Salt S =  $\text{Na}_2\text{S}_2\text{O}_3$



5. (d):  $\text{Ca} + 2\text{HCl} \longrightarrow \text{CaCl}_2 + \text{H}_2$

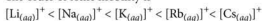


6. (c): The hydration enthalpies of alkali metal ions decrease with increase in ionic size i.e.,



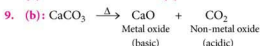
Hence, lithium having maximum degree of hydration will be least mobile.

The order of ionic mobility is



7. (d)

8. (b)



10. (d):  $\text{BeH}_2$  exists in polymeric form ( $3c-2e^-$  bonding).

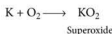


11. (a)

12. (c): Reactivity order :

Atomic hydrogen > Nascent hydrogen > Molecular hydrogen.

13. (d):  $4\text{Li} + \text{O}_2 \longrightarrow 2\text{Li}_2\text{O}$  ;  $2\text{Na} + \text{O}_2 \longrightarrow \text{Na}_2\text{O}_2$
- Normal oxide Peroxide

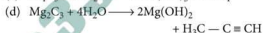


14. (c): (At cathode) (At anode)



15. (d)

16. (d): (a)  $\text{CaC}_2 + 2\text{H}_2\text{O} \longrightarrow \text{Ca}(\text{OH})_2 + \text{HC} \equiv \text{CH}$



17. (a): All elements of s-block (IA and IIA groups) except Be and Mg gives characteristic colour to the flame.

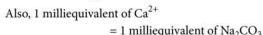
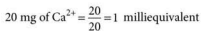
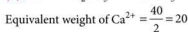
18. (a)

19. (d):  $\text{SO}_3 + \text{D}_2\text{O} \longrightarrow \text{D}_2\text{SO}_4$

(Deuteriosulphuric acid)

20. (d): Be forms water soluble  $\text{BeSO}_4$ , water insoluble  $\text{Be}(\text{OH})_2$  and  $\text{BeO}$ .  $\text{Be}(\text{OH})_2$  is soluble in  $\text{NaOH}$  giving sodium beryllate  $\text{Na}_2\text{BeO}_2$ .

21. (b):  $\text{Ca}^{2+} + \text{Na}_2\text{CO}_3 \longrightarrow \text{CaCO}_3 + 2\text{Na}^+$



Therefore, 1 milliequivalent of  $\text{Na}_2\text{CO}_3$  will be required to soften 1 litre of hard water.

22. (d)

23. (c)

24. (c): Calgon is  $\text{Na}_2[\text{Na}_4(\text{PO}_3)_6]$ .

25. (b)



## Class XI

Be JEE

READY

with exclusive and brain  
storming MCQs

Practicing these MCQs helps to strengthen your concepts and give you extra edge in your JEE preparation

1. 0.4426 g of a metallic chloride was dissolved in water and solution made up to 100 mL. 50 mL of this solution required 1.02 g of  $\text{AgNO}_3$  to precipitate the chloride completely. The specific heat of the metal was 0.057. What are the exact atomic weight and valency of the metal respectively?
- (a) 128.80, 3 (b) 120.30, 2  
(c) 150.70, 2 (d) 114.78, 3

2. Consider the following facts:
- (i) Cs is the strongest reducing agent in gaseous phase in IA group element.  
(ii) Be does not form peroxide in HA group elements.  
(iii) The density of potassium is less than sodium.  
(iv) In alkali metals Li, Na, K and Rb, lithium has the minimum value of melting point.

Point out that the statement

- (a) (i) and (ii) are correct  
(b) (i), (ii) and (iii) are correct  
(c) (ii) and (iii) are correct  
(d) (ii), (iii) and (iv) are correct
3. For the reversible system;  $X_{(g)} \rightleftharpoons Y_{(g)} + Z_{(g)}$ , a quantity of X was heated at constant pressure P at a certain temperature. The equilibrium partial pressure of X was found to be  $P/7$ . What is the value of  $K_p$  at given temperature?

- (a)  $6P/7$  (b)  $9P/7$  (c)  $36P/7$  (d)  $6P$

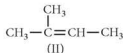
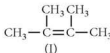
4. Iodine molecule dissociates into atoms after absorbing light of 4500 Å. If one quantum of radiation is absorbed by each molecule, calculate the kinetic energy of iodine atoms (Bond energy of  $I_2 = 240 \text{ kJ mol}^{-1}$ )
- (a)  $0.216 \times 10^{-19} \text{ J}$  (b)  $0.532 \times 10^{-20} \text{ J}$   
(c)  $0.732 \times 10^{-21} \text{ J}$  (d)  $0.832 \times 10^{-24} \text{ J}$

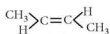
5. Select the one which does not result in the formation of aromatic species.



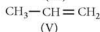
6. The average speed at  $T_1 \text{ K}$  and the most probable speed at  $T_2 \text{ K}$  of  $\text{CO}_2$  gas is  $9 \times 10^4 \text{ cm sec}^{-1}$ . What is the ratio of  $T_2 : T_1$ ?
- (a) 5 : 4 (b) 4 : 5  
(c) 2 : 5 (d) 1 : 3

7. The relative reactivity of the compounds

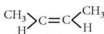




(III)



(V)



(IV)



(VI)

is in the order

- (a) I > II > III > IV > V > VI  
 (b) VI > V > IV > III > II > I  
 (c) I > III > V > II > IV > VI  
 (d) II > I > IV > III > V > VI
8. 0.257 g of an organic substance was heated with conc.  $\text{H}_2\text{SO}_4$  and then distilled with excess of strong alkali. The ammonia gas evolved was absorbed in 50 mL of N/10 HCl which required 23.2 mL of N/10 NaOH for neutralisation at the end of the process. The percentage of nitrogen in the compound is  
 (a) 14.6 (b) 18.0 (c) 17.0 (d) 15.5
9. Which of the following match is not correct?  
 (a)  $\text{SO}_3$ ,  $\text{O}_3$ ,  $\text{NH}_4^+$  : All have coordinate bonds  
 (b)  $\text{H}_2\text{O}$ ,  $\text{NO}_2$ ,  $\text{ClO}_2$  : All are 'V' shaped molecules  
 (c)  $\text{I}_3$ ,  $\text{ICl}_2$ ,  $\text{NO}_2^+$  : All are linear molecules  
 (d)  $\text{SF}_6$ ,  $\text{SiF}_4$ ,  $\text{XeF}_4$  : All are tetrahedral in shape

10. A hydrocarbon, 'X' ( $\text{C}_5\text{H}_4$ ) decolourise bromine in carbon tetrachloride forming 'Y'. 'X' gave a red precipitate of a compound 'Z' with ammoniacal cuprous chloride and formed a carbonyl compound with dilute sulphuric acid in the presence of  $\text{Hg}^{2+}$  ions. X, Y and Z are respectively

- (a)  $\text{CH}_2=\text{C}=\text{CH}_2$ ,  $\text{CH}_2\text{Br}-\text{CBr}_2-\text{CH}_2\text{Br}$ ,  $\text{CH}_3-\text{C}\equiv\text{C}-\text{Cu}$   
 (b)  $\text{CH}_3-\text{C}\equiv\text{CH}$ ,  $\text{CH}_3-\text{CBr}_2-\text{CHBr}_2$ ,  $\text{CH}_3-\text{C}\equiv\text{C}-\text{Cu}$   
 (c)  $\text{CH}_3-\text{C}\equiv\text{CH}$ ,  $\text{CH}_3-\text{CBr}=\text{CHBr}$ ,  $\text{CH}_2\text{Cu}-\text{C}\equiv\text{CH}$   
 (d)  $\text{CH}_2=\text{C}=\text{CH}_2$ ,  $\text{CH}_2\text{Br}-\text{CH}=\text{CHBr}$ ,  $\text{CH}_3-\text{C}\equiv\text{C}-\text{Cu}$

11. Which of the following statements is incorrect in the context of the B-F bond in  $\text{BF}_3$ ?  
 (a) All the three B-F bond lengths are equal and each of them is shorter than the sum of the covalent radii of boron and fluorine.  
 (b) The bond energy of the B-F bond is very high, higher than for any other single bond.  
 (c) The unusual shortness and strength of the B-F bond may be explained by a  $p\pi-p\pi$  interaction between boron and fluorine atoms.

- (d) The unusual shortness and strength of the bonds may be explained by a  $p\pi-p\pi$  interaction between the atoms of boron and fluorine.

12. Which of the following reaction does not give benzoic acid?

- (a)  $\text{C}_6\text{H}_5-\text{CH}_3 \xrightarrow[\text{KMnO}_4]{\text{Acidic}}$   
 (b)  $\text{C}_6\text{H}_5-\text{CH}_3 \xrightarrow[\text{H}_2\text{O}]{\text{CrO}_2\text{Cl}_2} \xrightarrow{[\text{O}]}$   
 (c)  $\text{C}_6\text{H}_5\text{C}\equiv\text{CH} \xrightarrow[\text{KMnO}_4]{\text{Acidic}}$   
 (d)  $\text{C}_6\text{H}_5-\text{C}(\text{CH}_3)_2-\text{H} \xrightarrow[\text{(ii) H}_2\text{O}]{\text{(i) O}_2}$

13.  $\text{SiCl}_4 \xrightarrow{\text{H}_2\text{O}} (\text{A}) \xrightarrow{\Delta} (\text{B}) \xrightarrow[\text{heat}]{\text{Na}_2\text{CO}_3} (\text{C})$ .

The compound C is

- (a)  $\text{SiO}_2$  (b) Si (c) SiC (d)  $\text{Na}_2\text{SiO}_3$

14. Which among the following statements are correct?

- (1) Energy needed for homolytic bond fission is less than that required for the heterolytic bond fission.  
 (2) Homolytic bond fission gives neutral species which is paramagnetic in nature.  
 (3) Energy needed for heterolytic bond fission is less than that required for the homolytic bond fission.  
 (4) Heterolytic bond fission takes place in non polar solvents.  
 (a) Only 1 (b) Only 1 and 3  
 (c) Only 1 and 2 (d) Only 1, 2 and 4

15. In which of the following ionization processes, the bond order has increased and the magnetic behaviour has changed?

- (a)  $\text{NO} \rightarrow \text{NO}^+$  (b)  $\text{O}_2 \rightarrow \text{O}_2^+$   
 (c)  $\text{N}_2 \rightarrow \text{N}_2^+$  (d)  $\text{C}_2 \rightarrow \text{C}_2^+$

## PUZZLE CORNER

SOLUTION - OCTOBER 2018

1	5	4	2	3
3	1	2	4	5
4	2	5	3	1
5	4	3	1	2
2	3	1	5	4

- (a) Neon ( $1+5+3+1$ ) = 10  
 (b) Curium ( $4 \times 2 \times 3 \times 4$ ) = 96  
 (c) Zirconium ( $4 \times 2 \times 5$ ) = 40  
 (d) Fluorine ( $5+3+1$ ) = 9  
 (e) Nitrogen ( $5+2$ ) = 7  
 (f) Krypton ( $4 \times 3 \times 3 \times 1$ ) = 36  
 (g) Boron ( $5 \times 1$ ) = 5  
 (h) Helium ( $4-2$ ) = 2



## SOLUTIONS

1. (d) : Let the equivalent weight of metal be
- $E$

$$\frac{\text{Weight of metal chloride}}{\text{Weight of silver nitrate}} = \frac{\text{Eq. wt. of metal chloride}}{\text{Eq. wt. of silver nitrate}}$$

$$\frac{0.4426}{1.02} = \frac{E + 35.5}{170} \therefore E = 38.26$$

According to Dulong Petit's rule :

$$\text{Atomic wt} \times \text{Sp. heat} = 6.4$$

$$\text{Atomic wt.} = \frac{6.4}{0.057} = 112.3$$

$$\therefore \text{Valency} = \frac{\text{Atomic wt.}}{\text{Eq. wt.}} = \frac{112.3}{38.26} = 3$$

$$\text{Hence, exact atomic wt.} = 38.26 \times 3 = 114.78$$

2. (b)

3. (b) : For
- $X_{(g)} \rightleftharpoons Y_{(g)} + Z_{(g)}$
- ;

$$\begin{array}{ccc} a & 0 & 0 \\ a-x & x & x \end{array}$$

$$P'_x = P \frac{(a-x)}{(a+x)} = \frac{P}{7}$$

$$\therefore 7a - 7x = a + x,$$

$$x = \frac{6a}{8} = \frac{3a}{4}$$

$$\text{Also, } K_p = \frac{x^2}{(a-x)} \times \left[ \frac{P}{a+x} \right] = \frac{9a^2 \times 4}{16 \times a} \times \frac{P \times 4}{7a} = \frac{9P}{7}$$

4. (a) : Energy given to
- $I_2$
- molecule =
- $\frac{hc}{\lambda}$

$$= \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{4500 \times 10^{-10}} = 4.417 \times 10^{-19} \text{ J}$$

Energy used for breaking up of  $I_2$  molecule

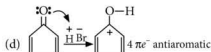
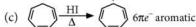
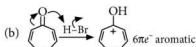
$$= \frac{240 \times 10^3}{6.023 \times 10^{23}} = 3.984 \times 10^{-19} \text{ J}$$

 $\therefore$  Energy used in imparting K.E. to two I atoms

$$= (4.417 \times 10^{-19} - 3.984 \times 10^{-19}) \text{ J} = 0.433 \times 10^{-19} \text{ J}$$

$$\text{K.E. per atom} = 0.216 \times 10^{-19} \text{ J}$$

5. (d) : (a)
- 
- $6\pi e^-$
- aromatic



6. (a) : Average speed at
- $T_1 K = \sqrt{\frac{8RT_1}{\pi M}}$

$$\text{Most probable speed at } T_2 K = \sqrt{\frac{2RT_2}{M}}$$

According to question,

$$\sqrt{\frac{8RT_1}{\pi M}} = \sqrt{\frac{2RT_2}{M}} = 9 \times 10^4$$

$$\text{i.e., } \sqrt{\frac{8T_1}{\pi}} = \sqrt{2T_2} \quad \text{or} \quad \frac{8T_1}{\pi} = 2T_2$$

$$\frac{8}{\pi \times 2} = \frac{T_2}{T_1} \Rightarrow \frac{T_2}{T_1} = \frac{5}{4}$$

7. (b) : As number of alkyl groups around double bond increase, stability of alkene increases and hence, reactivity decreases. Also
- cis*
- alkene is more reactive than
- trans*
- alkene. Therefore, the order of reactivity of the given compounds is as follows :



8. (a) : Volume of
- $\frac{N}{10}$
- HCl taken = 50 mL

Volume of  $\frac{N}{10}$  NaOH for neutralisation of unused acid = 23.2 mL

$$\text{Now } N_1 V_1 (\text{NaOH}) = N_2 V_2 (\text{HCl})$$

$$23.2 \text{ mL of } \frac{N}{10} \text{ NaOH} = V_2 \text{ mL of } \frac{N}{10} \text{ HCl}$$

$$\therefore \text{Volume of } \frac{N}{10} \text{ HCl unused} = 23.2 \text{ mL}$$

$$\therefore \text{Volume of } \frac{N}{10} \text{ HCl required for neutralisation}$$

$$\text{of } \text{NH}_3 = 50 - 23.2 = 26.8 \text{ mL}$$

$$26.8 \text{ mL of } \frac{N}{10} \text{ HCl} = 26.8 \text{ mL of } \frac{N}{10} \text{ NH}_3$$

$$1000 \text{ mL of } 1 \text{ N } \text{NH}_3 \text{ solution contains nitrogen} = 14 \text{ g}$$

## MONTHLY TUNE UP CLASS XII

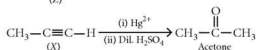
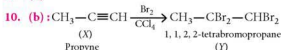
## ANSWER KEY

- |           |           |             |            |         |
|-----------|-----------|-------------|------------|---------|
| 1. (a)    | 2. (d)    | 3. (b)      | 4. (a)     | 5. (c)  |
| 6. (a)    | 7. (a)    | 8. (c)      | 9. (c)     | 10. (a) |
| 11. (c)   | 12. (b)   | 13. (b)     | 14. (c)    | 15. (c) |
| 16. (c)   | 17. (b)   | 18. (c)     | 19. (b)    |         |
| 20. (a,d) | 21. (b,d) | 22. (a,c,d) | 23. (c, d) | 24. (4) |
| 25. (3)   | 26. (6)   | 27. (a)     | 28. (b)    | 29. (c) |
| 30. (d)   |           |             |            |         |

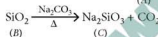
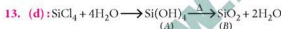
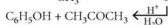
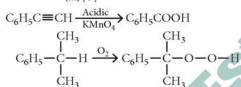
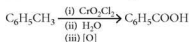
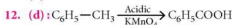
$$26.8 \text{ mL of } \frac{N}{10} \text{ NH}_3 \text{ solution contains nitrogen} = \frac{14 \times 26.8}{10 \times 1000}$$

$$\text{Percentage of nitrogen} = \frac{14 \times 26.8 \times 100}{10 \times 1000 \times 0.257} = 14.6\%$$

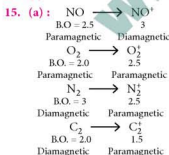
9. (d)



11. (d)



14. (c)



# CHEMISTRY AROUND US



Understand the Chemistry behind  
Real Life Phenomena

## WHY DOES YOUR COFFEE TASTE AND SMELL DELICIOUS?

The major difference between coffee roasts comes from the chemical reactions that occur in the coffee beans at certain temperatures. As a result of these chemical reactions, aromatics, acids and other flavor components are created, balanced or altered in a way to build the perfect flavor, acidity, aftertaste and body of coffee.

### 1. MAILLARD REACTION

A key reaction for the development of roasted coffee flavor and color is the Maillard reaction. At temperature from 150–200°C, carbonyl groups (from sugars) and amino groups in proteins react to form aroma and flavor compounds.

#### FLAVOUR COMPOUNDS



The roasted flavor in coffee comes from 2-furfurylthiol



Trigonelline gives coffee that bitter taste

### 2. CARAMELIZATION

From 170–200°C the sugars in coffee start caramelizing, which browns the sugar and releases aromatic and acidic compounds. Diacetyl gives coffee or buttery or butterscotch flavor.

### 3. FIRST CRACK

Around 205°C water inside the bean vaporizes, causing the bean to expand and crack. At this point, the bean loses about 5% of its weight from water loss.

### 4. PYROLYSIS

At approximately 220°C, the heat causes a chemical change inside the bean, leading to the release of carbon dioxide. Acetaldehyde is produced during pyrolysis and has a green apple aroma. The bean loses 13% of its weight.

### 5. SECOND CRACK

Pyrolysis continues as temperatures reach 225–230°C, causing the second crack in the bean. That second crack is the cellulose in the cell wall of the bean breaking apart. It's during this step where the aromatic compounds are released, contributing the coffee's classic flavor.

#### AROMATIC COMPOUNDS



2-isobutyl-3-methoxypyrazine gives coffee an earthy scent



2-ethyl-3,5-dimethylpyrazine adds earthy, roasted notes

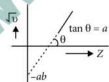
# BRUSH UP

# YOUR CONCEPTS

Class  
XI

This specially designed column will help you to brush up your concepts by practicing questions. You can mail us your queries and doubts related to this topic at editor@mtg.in. The queries will be entertained by the author.\*

## CLASSIFICATION OF ELEMENTS AND PERIODICITY IN PROPERTIES

- In 1800, only 31 elements were known while at present 118 elements have been well established. The maximum number of elements will go upto 137.
- When the need of classification for easy study of elements and their compounds was felt, in 1829 Johann Dobereiner was the pioneer to give triads of few elements. Three elements resemble in properties if the mass of one is approximately average of the other two.
- It was followed by cylindrical table by Chancourtois (1862), Law of octaves (classification upto Ca only) by Newlands (1865), etc, the best being Mendeleev's (1869) periodic table that used the ever first periodic law :  
The properties of elements are periodic function of their atomic masses.  
Gaps in Mendeleev's periodic table were filled by giving names to unknown elements using names of their predecessors in their groups, e.g., Eka-Silicon for Germanium.
- In 1913, Henry Moseley experimentally found that atomic number to be more fundamental than atomic mass for relating properties.  
  
He plotted  $\sqrt{\nu}$  of X-rays emitted by elements with their atomic numbers and form a direct relation,  $\sqrt{\nu} = aZ - ab$ .  
The modern periodic law is given as : "The properties of elements are the periodic functions of their atomic numbers."
- The modern 'Long form' of periodic table was made by Werner, Rang, Bury, etc. Eighteen vertical columns 1-18 are called groups and seven I to VII horizontal rows are called periods.
- Groups 1 (alkali metals) and 2 (alkaline earths) form *s*-block with general electronic configuration  $ns^{1-2}$ . These are highly reducing metals and form ionic compounds with exception of Li and Be. Groups 13 to 18 form *p*-block with general electronic configuration  $ns^2 np^{1-6}$ . Elements of *s*- and *p*-block together are representative or normal or main group elements. Some specific names of groups are :  
15<sup>th</sup> → Pnictogens  
16<sup>th</sup> → Chalcogens  
17<sup>th</sup> → Halogens  
18<sup>th</sup> → Noble gases elements.  
Extreme left side elements are metals and right side are non-metals. Si, Ge, As, Sb, Te, Po and At are metalloids or semi-metals.  
Groups 3 to 12 elements in the centre of the periodic table use  $(n-1)d$  subshell for filling of electrons and form *d*-block with general electronic configuration  $(n-1)d^{1-10} ns^{0-2}$ . Except Zn, Cd and Hg all elements are called transition elements.
- Elements Lanthanoids (Ce – 58 to Lu – 71) and Actinoids (Th – 90 to Lr – 103) are characterised by  $(n-2)f^{1-14} (n-1)d^{0-1} ns^2$  form two rows at the bottom as *f*-block. Elements after U-92 are called transuranic elements. These all belong to 3<sup>rd</sup> group.

\*By R.C. Grover, having 45+ years of experience in teaching chemistry.

○ **Periodic trends of properties are shown as :**

- (I) Increasing along a period : electronegativity, ionisation enthalpy (in general), non-metallic character, electron gain enthalpy, acidic character of oxides.
- (II) Decreasing along a period : metallic character.
- (III) Increasing down a group : atomic and ionic radii [ $r_{\text{cation}} < r_{\text{atom}} < r_{\text{anion}}$ ]; exception  $r_{\text{Ga}} < r_{\text{Al}}$ , basic strength of oxides and hydroxides, metallic character.
- (IV) Decreasing down a group : electronegativity, ionisation enthalpy, electron gain enthalpy.

○ Diagonal relationship exists between Li and Mg due to very close atomic radii 152 pm and 160 pm, also their ionic radii 76 pm and 72 pm respectively. Be resembles Al because of same electronegativity 1.5 and very close ionic potential (polarising power =  $\frac{\text{charge}}{\text{size}}$ )

$\text{Be}^{2+} = 0.064$  and  $\text{Al}^{3+} = 0.060$ . B resembles Si because of very close electronegativities 2.0 and 1.8 respectively.

Order of I.P. in 2<sup>nd</sup> period :

$\text{Li} < \text{B} < \text{Be} < \text{C} < \text{O} < \text{N} < \text{F}$

Order of 2<sup>nd</sup> I.P. in 2<sup>nd</sup> period :

$\text{Be} < \text{C} < \text{B} < \text{N} < \text{F} < \text{O} < \text{Li}$

$\Delta_{\text{eg}}H$  of chalcogens :  $\text{S} > \text{Se} > \text{Te} > \text{Po} > \text{O}$

$\Delta_{\text{eg}}H$  of halogens :  $\text{Cl} > \text{F} > \text{Br} > \text{I}$  (–ve value)

### MULTIPLE CHOICE QUESTIONS

1. An element has electronic configuration [Rn]5f<sup>6</sup> 6d<sup>0</sup> 7s<sup>2</sup>. It belongs to
  - (a) 8<sup>th</sup> group
  - (b) 6<sup>th</sup> group
  - (c) 2<sup>nd</sup> group
  - (d) 3<sup>rd</sup> group.
2. Which of the following element has highest density?
  - (a) Fe
  - (b) Pt
  - (c) Os
  - (d) U
3.  $\text{O}_{(g)} + e^- \rightarrow \text{O}_{(g)}^-; \Delta H^\circ = -141 \text{ kJ mol}^{-1}$   
 $\text{O}_{(g)} + e^- \rightarrow \text{O}_{(g)}^{2-}; \Delta H^\circ = +780 \text{ kJ mol}^{-1}$   
 This shows that the process of formation of  $\text{O}^{2-}$  is unfavourable even though  $\text{O}^{2-}$  is isoelectronic with Ne. It is due to the fact that
  - (a)  $\text{O}^-$  is comparatively smaller in size than O-atom
  - (b) oxygen is highly electronegative
  - (c) addition of electron in oxygen results in larger size of the anion
  - (d) electron repulsion outweighs the stability gained by achieving noble gas configuration.
4. Which of the following is correct for ionic size?
  - (a)  $\text{C}^{4-} > \text{N}^{3-} > \text{O}^{2-} > \text{F}^-$
  - (b)  $\text{F}^- > \text{O}^{2-} > \text{N}^{3-} > \text{C}^{4-}$
  - (c)  $\text{N}^{3-} > \text{C}^{4-} > \text{F}^- > \text{O}^{2-}$
  - (d)  $\text{F}^- > \text{N}^{3-} > \text{O}^{2-} > \text{C}^{4-}$
5. Which of the following is correct order of the size of species of tin?
  - (a)  $\text{Sn} > \text{Sn}^{2+} > \text{Sn}^{4+}$
  - (b)  $\text{Sn}^{4+} > \text{Sn}^{2+} > \text{Sn}$
  - (c)  $\text{Sn}^{2+} > \text{Sn}^{4+} > \text{Sn}$
  - (d)  $\text{Sn}^{2+} > \text{Sn} > \text{Sn}^{4+}$
6. Correct order of ionisation energy of C, N, O and F is
  - (a)  $\text{F} < \text{N} < \text{C} < \text{O}$
  - (b)  $\text{C} < \text{N} < \text{O} < \text{F}$
  - (c)  $\text{F} < \text{O} < \text{N} < \text{C}$
  - (d)  $\text{C} < \text{O} < \text{N} < \text{F}$
7. Correct order of 2<sup>nd</sup> ionisation energies is shown in
  - (a)  $\text{Li} < \text{C} < \text{B} < \text{F} < \text{O}$
  - (b)  $\text{C} < \text{B} < \text{F} < \text{O} < \text{Li}$
  - (c)  $\text{Li} < \text{B} < \text{C} < \text{O} < \text{F}$
  - (d)  $\text{B} < \text{C} < \text{F} < \text{O} < \text{Li}$
8. The correct order of  $\Delta_{\text{eg}}H$  of halogens (–ve values) is shown in
  - (a)  $\text{F} < \text{Cl} < \text{Br} < \text{I}$
  - (b)  $\text{Cl} > \text{F} > \text{Br} > \text{I}$
  - (c)  $\text{F} > \text{Cl} > \text{Br} > \text{I}$
  - (d)  $\text{Cl} > \text{Br} > \text{F} > \text{I}$
9. Which of the following has largest difference between 1<sup>st</sup> and 2<sup>nd</sup> ionisation energies?
  - (a)  $1s^2 2s^2 2p^6 3s^2 3p^6$
  - (b)  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
  - (c)  $1s^2 2s^2 2p^6 3s^2$
  - (d)  $1s^2 2s^2 2p^6 3s^2 3p^1$
10. Five successive ionisation energies of an element are listed below (in kJ mol<sup>-1</sup>).
 

1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>
577	1810	2750	11580	14820

The element is

  - (a) Ca
  - (b) P
  - (c) Al
  - (d) K



### COMIC CAPSULE



IF YOU ARE NOT PART OF THE  
**SOLUTION** ...  
 YOU ARE PART OF THE  
**PRECIPITATE!**

11. The electron affinity of Ar is  
(a) highly positive (b) positive but low  
(c) negative (d) zero.
12. Which of the following involves the highest release of energy?  
(a)  $S + 2e^- \rightarrow S^{2-}$  (b)  $O + 2e^- \rightarrow O^{2-}$   
(c)  $F + e^- \rightarrow F^-$  (d)  $I + e^- \rightarrow I^-$
13.  $10^6 I + 10^6 e^- \rightarrow 10^6 I^-$ ;  $\Delta H = -5.6 \times 10^{-13} J$ . What is the electron gain enthalpy of iodine in electron volt? ( $1 eV = 1.6 \times 10^{-19} J$ )  
(a)  $-8.96 eV$  (b)  $-3.50 eV$   
(c)  $-2.8 eV$  (d)  $-7.2 eV$
14. The valency shown by oxygen in  $M_2O_3$  is  
(a) +2 (b) -2 (c) 2 (d) 3
15. Which of the following represents the correct decreasing order of acidic character of oxides?  
(a)  $BeO > B_2O_3 > CO_2 > N_2O_5$   
(b)  $B_2O_3 > BeO > N_2O_5 > CO_2$   
(c)  $N_2O_5 > CO_2 > B_2O_3 > BeO$   
(d)  $CO_2 > N_2O_5 > B_2O_3 > BeO$
16. The correct decreasing order of electronegativity is shown in  
(a)  $N > P > B > Al$  (b)  $P > N > Al > B$   
(c)  $P > N > B > Al$  (d)  $B > Al > P > N$
17. Pauling calculated electronegativities of elements taking value 4 for fluorine by using  
(a) I.E. and E.A. (b) bond energy  
(c) valence and atomicity  
(d) none of these.
18. Which of the following decreases along a period?  
(a) Metallic character  
(b) Electronegativity  
(c) Ionisation enthalpy  
(d) Electron gain enthalpy
19. Elements X and Y have valence shell electronic configuration  $ns^2 np^3$  and  $ns^2 np^4$ . The chemical formula of the compound formed by them is likely to be  
(a) XY (b)  $X_2Y$  (c)  $XY_2$  (d)  $X_2Y_3$
20. The correct order of electronegativity is shown in  
(a)  $Mg > Be > Al > B$  (b)  $B > Al = Be > Mg$   
(c)  $B = Be > Al = Mg$  (d)  $B > Al > Be > Mg$
21. **Assertion (A)** :  $Ca^{2+}$  has much higher hydration energy than  $Na^+$ .  
**Reason (R)** : Charge/size ratio of  $Ca^{2+}$  is approximately double that of  $Na^+$ .  
(a) If (A) and (R) both are correct and (R) is the correct reason of (A).  
(b) If (A) and (R) both are correct and (R) is not the correct reason of (A)  
(c) If (A) is correct but (R) is incorrect.  
(d) If both (A) and (R) are incorrect.
22. **Assertion (A)** : Latin based digit 1 is un, 2 is bi and 8 is oct.  
**Reason (R)** : The atomic number of element unbiocium is 118.  
(a) If (A) and (R) both are correct and (R) is the correct reason of (A).  
(b) If (A) and (R) both are correct and (R) is not the correct reason of (A).  
(c) If (A) is correct but (R) is incorrect.  
(d) If both (A) and (R) are incorrect.
23. The general electronic configuration of actinoids is  
(a)  $4f^{1-14} 5s^2 5p^6 5d^{0-1} 6s^2$   
(b)  $5f^{1-14} 6s^2 6p^6 6d^{0-1} 7s^2$   
(c)  $4d^{0-1} 5f^{1-14} 6s^2$  (d)  $5d^{0-1} 6f^{1-14} 7s^2$
24. Atomic radius of A for  $A \equiv A$  based on bond length of  $A = A$  being 132.5 pm will be approximately  
(a) 66.25 pm (b) 99.37 pm  
(c) 59.30 pm (d) 77.0 pm
25. The 1<sup>st</sup> ionisation energy of Mg is  
(a) zero (b) more than Al  
(c) less than Al (d) equal to Al.

### SOLUTIONS

1. (d) : The element is Pu - 94, an actinoid belonging to 7<sup>th</sup> period and 3<sup>rd</sup> group.
2. (c)
3. (d) : The net energy for the reaction,  $O_{(g)} + 2e^- \rightarrow O_{(g)}^{2-}$ , is + 639 kJ mol<sup>-1</sup> because  $O^-$  repels  $e^-$ .
4. (a) :  $C^{4-}$ ,  $N^{3-}$ ,  $O^{2-}$  and  $F^-$  are isoelectronic with 10 electrons each. Now, higher the number of protons (at. no.) smaller is the size.
5. (a) : Higher the positive charge on cation (same element), smaller is the radius of the ion.
6. (d) : I.E. of N  $1s^2 2s^2 2p^3$  is higher than that of O-atom due to stable half filled electronic configuration.
7. (b) :  $B^+$   $1s^2 2s^2$  has higher 2<sup>nd</sup> I.E. than  $C^+$   $1s^2 2s^2 2p^1$ .  $O^+$   $1s^2 2s^2 2p^3$  has higher 2<sup>nd</sup> I.E. than  $F^+$   $1s^2 2s^2 2p^4$ .  $Li^+$   $1s^2$  has highest I.E. among all these cases.

8. (b): F-atom has lesser  $\Delta_{\text{eg}} H$  value than Cl-atom because of high repulsion on incoming electron by the dense cloud of seven  $2s^2 2p^5$  electrons.
9. (c): After removal of  $4s^1$  electron the left over set of electrons has [Ar] configuration.
10. (c): Because  $4^{\text{th}}$  I.E. is much higher than the  $3^{\text{rd}}$  I.E., the element has 3 electrons in its valence shell. It is  $\text{Al} - 1s^2 2s^2 2p^6 3s^2 3p^1$
11. (d): Ar does not form  $-ve$  ion.
12. (c): In cases (a) and (b)  $S^-$  and  $O^-$ , respectively, first formed will repel the  $2^{\text{nd}}$  incoming electron. F-atom is smaller in size than I-atom and hence will release more energy.
13. (b):  $10^6$  I-atoms release energy =  $-5.6 \times 10^{-13}$  J  
 One I-atom releases energy =  $\frac{-5.6 \times 10^{-13}}{10^6}$  J  
 $= -\frac{5.6 \times 10^{-13}}{10^6 \times 1.6 \times 10^{-19}} \text{ eV} = -3.5 \text{ eV}$
14. (c): Valency of oxygen is '2'. If we opt for (b) i.e. -2, it will show oxidation number and not the valency.
15. (c): Along a period acidic character of oxides increases.
16. (a):  $\text{N}(3.0) > \text{P}(2.1) > \text{B}(2.0) > \text{Al}(1.5)$
17. (b) 18. (a)
19. (d): X can give 3 electrons while Y can take 2 electrons.



20. (b):  $\text{B}(2.0) > \text{Al} = \text{Be}(1.5) > \text{Mg}(1.2)$
21. (a) 22. (c)
23. (b): Actinoids are in  $7^{\text{th}}$  period. These have general electronic configuration  $5f^{1-14} 6s^2 6p^6 6d^{0-1} 7s^2$ .
24. (c): If atomic radius of A in  $A-A$  is  $x$ , then in  $A=A$ , it is  $0.86x$  and in  $A \equiv A$ , it is  $0.77x$  (approximately).  
 In  $A=A$ , radius =  $\frac{132.5}{2} = 66.25 \text{ pm}$   
 $\Rightarrow 0.86x = 66.25 \Rightarrow x = \frac{66.25}{0.86}$   
 Radius of A in  $A \equiv A = 0.77x = \frac{0.77 \times 66.25}{0.86}$   
 $= 59.32 \text{ pm}$
25. (b): I.E. of  $\text{Mg} = 1s^2 2s^2 2p^6 3s^2$  is higher than that of  $\text{Al} = 1s^2 2s^2 2p^6 3s^2 3p^1$  because  $s$ -subshell has higher penetration than  $p$ -subshell.

## TOP 10 UNIVERSITIES OF THE WORLD

As per the Times Higher Education's World University Rankings for 2019, here are the list of top ten universities of the world.

### 1 UNIVERSITY OF OXFORD

Oxford is one of the oldest universities "in the English-speaking world", according to the ranking. It has the United Kingdom's largest library systems with over 100 libraries. The campus includes 19,718 students, 35 per cent of whom are international students. The university is the first ranking institute in clinical, pre-clinical and health education and secured high ranks in other education departments including Life Sciences, Business and Economics, Computer Science, Physical Science and Arts and Humanities.

### 2 UNIVERSITY OF CAMBRIDGE

Cambridge University is 800 years old, which makes it the fourth-oldest surviving educational institute in the world. It has six schools, Arts and Humanities, Biological Sciences, Clinical Medicine, Humanities and Social Sciences, Physical Sciences and Technology, which house 150 faculties and other institutes.

### 3 STANFORD UNIVERSITY

This university was established in 1885 and has its roots in the aftermath of World War-II and was instrumental in the development of the Silicon Valley. It has 700 university buildings, 40 departments, three academic and four professional schools, 18 independent labs, centres and institutes.

### 4 MASSACHUSETTS INSTITUTE OF TECHNOLOGY

MIT is divided into five different schools for architecture and planning, engineering, humanities, arts and social sciences, management and science. There are 1,000 faculty members and over 11,000 undergraduate and graduate students in the university.

### 5 CALIFORNIA INSTITUTE OF TECHNOLOGY

Ranked fifth, this university is a world-renowned science and engineering research and education institution. It was founded in 1981 and was called "Throop University" before it was renamed in 1920. The institute has an approximate professorial faculty of 300 and more than 600 research scholars. The California Institute of Technology is considered the current best university for engineering and technology in the world.

### 6 HARVARD UNIVERSITY

This is a private Ivy League institution. The campus has 12 schools, a Radcliffe Institute for Advanced Study, two theatres and five museums. The largest academic university in the world is located on Harvard's campus.

### 7 PRINCETON UNIVERSITY

Princeton was founded in 1746 as the "College of New Jersey" and is another Ivy League private institution.

### 8 YALE UNIVERSITY

Featured in top eight by Times Higher Education World University Ranking, 2019, the university is the third oldest private university in the United States of America and was founded in 1701.

### 9 IMPERIAL COLLEGE LONDON

This university was founded in 1907 and was merged with the Royal College of Science, the Royal School of Mines and the City and Guilds College. Currently, the college is hosting 15,000 students and 8,000 staff and provides courses in science, engineering, medicine and business.

### 10 UNIVERSITY OF CHICAGO

Established in 1890, the university was placed 10<sup>th</sup> by the world university ranking. The university has around 6,000 undergraduate students, and 10,000 postgraduates.

## CLASS XI

# CBSE DRILL



Chapterwise practice questions for CBSE Exams as per the latest pattern and marking scheme issued by CBSE for the academic session 2018-19.

## GENERAL INSTRUCTIONS

- |   |  |
|---|--|
| (i) All questions are compulsory.                                       | (ii) Q. no. 1 to 5 are very short answer questions and carry 1 mark each.    |
| (iii) Q. no. 6 to 12 are short answer questions and carry 2 marks each. | (iv) Q. no. 13 to 24 are also short answer questions and carry 3 marks each. |
| (v) Q. no. 25 to 27 are long answer questions and carry 5 marks each.   | (vi) Use log tables if necessary, use of calculators is not allowed.         |

Time Allowed : 3 hours

Maximum Marks : 70

## Hydrogen | The s-Block Elements

- Why is dihydrogen gas not preferred in balloons?
  - Lithium hydroxide has been used by astronauts for a particular purpose, explain it with reaction.
  - Write the name of an element of group 2 which forms an amphoteric oxide and water soluble sulphate. To which period, does it belong?
  - Why cannot sea animals live in distilled water?
  - A sample of hard water is allowed to pass through an anion exchanger. Will it produce lather with soap easily?
  - Give the composition and action of baking powder.
  - If same mass of liquid water and a piece of ice is taken, then why is the density of ice less than that of liquid water?
  - Why are  $\text{BeSO}_4$  and  $\text{MgSO}_4$  readily soluble in water while  $\text{CaSO}_4$ ,  $\text{SrSO}_4$  and  $\text{BaSO}_4$  are insoluble?
  - Why  $\text{Li}_2\text{CO}_3$  is unstable while all other alkali metal carbonates are relatively stable?
  - Phosphoric acid is preferred over sulphuric acid in preparing hydrogen peroxide from peroxides. Why?
- OR**
- Explain the correct context in which the following terms are used :
- (i) protium (ii) dihydrogen
  - (iii) proton (iv) hydron.
  - What do you understand by the term 'syn gas'?
  - How does hydration differ from hydrolysis?
  - What do you understand by (i) electron deficient (ii) electron precise and (iii) electron rich compounds of hydrogen? Explain with suitable examples.
  - Write complete reaction when hydrogen reacts under suitable conditions with
    - nitrogen
    - carbon monoxide
    - lead oxide.
  - How is soda ash prepared from washing soda?



16. (i) Sodium fire in the laboratory should not be extinguished by pouring water. Why?  
 (ii) Alkali metals are paramagnetic but their salts are diamagnetic. Explain.  
 (iii) Why superoxides of alkali metals are paramagnetic while normal oxides are diamagnetic?
17. What mass of hydrogen peroxide will be present in 2 litres of a 5 molar solution? Calculate the mass of oxygen which will be liberated by the decomposition of 200 mL of this solution.
18. Describe two important uses of each of the following:  
 (i) caustic soda (ii) sodium carbonate  
 (iii) quick lime.
19. 25 mL of hydrogen peroxide solution were added to excess of acidified potassium iodide solution. The iodine so liberated required 20 mL of 0.1 N sodium thiosulphate solution. Calculate strength in terms of normality, percentage and volume.
20. Why does the chemical reactivity of alkali metals increase from Li to Cs? What are the consequences of difference in charge / radius ratio of  $\text{Li}^+$  from other group 1 ions?

OR

Calcium burns in nitrogen to produce a white powder which dissolves in sufficient water to produce a gas (A) and an alkaline solution. The solution on exposure to air produces a thin solid layer of (B) on the surface. Identify the compounds A and B. Also give all the reactions involved.

21. What happens when,  
 (i) chromium hydroxide is treated with hydrogen peroxide in the presence of NaOH  
 (ii) hydrazine reacts with hydrogen peroxide  
 (iii) benzene is treated with  $\text{H}_2\text{O}_2$  in alkaline medium?
22. Answer the following questions:  
 (i) Among the alkali metals, why is Li the only element that forms a nitride by direct combination?  
 (ii) Why is LiF insoluble but LiCl soluble in water? If only one of them is soluble in acetone or ethanol, which is it?
23. (i) Why is  $\text{BeCO}_3$  stored in carbon dioxide atmosphere?  
 (ii) Why are beryllium halides polymeric in nature?  
 (iii) Why it is necessary to add gypsum in the final stages of preparation of cement?

24. Explain the following:

- (i) Hydrogen is not prepared by action of concentrated sulphuric acid on zinc.  
 (ii) A solution of ferric chloride is unaffected when hydrogen is bubbled through it, but gets reduced when zinc is added to the same acidified solution.  
 (iii) Hard water is softened before using in boilers.
25. (i) Name the groups which constitute s-block elements.  
 (ii) Why sodium and potassium cannot be prepared by the electrolysis of their aqueous solutions?  
 (iii) Why is the density of potassium less than sodium?  
 (iv) Why are alkali metals soft and have low melting points?  
 (v) What happens when K burns in air? Give chemical equation.

OR

Present a comparative account of the alkali and alkaline earth metals with respect to the following characteristics:

- (i) Tendency to form ionic/covalent compounds  
 (ii) Nature of oxides and their solubility in water  
 (iii) Formation of oxosalts  
 (iv) Solubility of oxosalts  
 (v) Thermal stability of oxosalts.
26. (i) Arrange giving explanation:  
 (a) LiH, NaH, CsH in increasing order of ionic character,  
 (b)  $\text{CaH}_2$ ,  $\text{BeH}_2$ ,  $\text{TiH}_4$  in increasing order of electrical conductance  
 (c) NaH,  $\text{MgH}_2$ ,  $\text{CaH}_2$  in increasing order of reducing power.  
 (ii) Describe the bulk preparation of hydrogen by electrolytic method. What is the role of an electrolyte in this process?

OR

Answer the following:

- (i) Explain the property of  $\text{H}_2\text{O}_2$  that is responsible for its bleaching action.  
 (ii) What is heavy water? Calculate the molecular weight of heavy water.  
 (iii) Why should heavy water plants be near to fertilizer industry?  
 (iv) What is the role of sodium hexametaphosphate in water softening process?  
 (v) Water cannot be used to extinguish petrol fires. Why?

27. (i) Describe the manufacture of caustic soda using the Castner-Kellner cell (the mercury cathode cell).

(ii) Draw a neat and labelled diagram of the Castner-Kellner cell.

OR

(i) Write chemical equations only, involved in the preparation of each of the following :

(a) Plaster of Paris (b) Quick lime

(c) Slaked lime

Also write any one use of each.

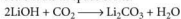
(ii) What happens when quick lime is heated with silica?

(iii) Give two biological importance of magnesium?

### SOLUTIONS

1. Dihydrogen gas is combustible in nature. Therefore, it may react with oxygen violently. Thus, it is not used in balloons.

2. It is used to absorb  $\text{CO}_2(\text{g})$  to provide comfort for astronauts in space crafts.

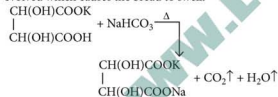


3. Beryllium. It belongs to second period.

4. Distilled water does not contain dissolved  $\text{O}_2$ . Sea animals cannot live in distilled water because of the absence of dissolved oxygen for breathing.

5. No,  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  ions are still present and these will interact with soap to form curdy white ppt. Therefore, it will not produce lather with soap easily.

6. It is mixture of potassium hydrogen tartrate and sodium bicarbonate. On heating (baking),  $\text{CO}_2(\text{g})$  is evolved which causes the bread to swell.



7. Since water expands on freezing, therefore, volume of ice for the same mass of water is more than liquid water. Hence mass per unit volume i.e., density of ice is lower than liquid water.

8. The hydration enthalpies of  $\text{BeSO}_4$  and  $\text{MgSO}_4$  are quite high because of small size of  $\text{Be}^{2+}$  and  $\text{Mg}^{2+}$  ions. These hydration enthalpy values are higher than their corresponding lattice enthalpies and therefore,  $\text{BeSO}_4$  and  $\text{MgSO}_4$  are highly soluble in water. However, hydration enthalpies of  $\text{CaSO}_4$ ,  $\text{SrSO}_4$  and  $\text{BaSO}_4$  are not very high as compared to lattice enthalpies and hence these are insoluble in water.

9.  $\text{Li}^+$  ion being small in size, cannot stabilize large  $\text{CO}_3^{2-}$  ion and therefore,  $\text{Li}_2\text{CO}_3$  is unstable. Other alkali metal ions are large in size and can easily stabilize large  $\text{CO}_3^{2-}$  ions. This is because of lattice energy effects.

10.  $\text{H}_2\text{SO}_4$  acts as a catalyst for decomposition of  $\text{H}_2\text{O}_2$ . Therefore, some weaker acid such as  $\text{H}_3\text{PO}_4$  is preferred over  $\text{H}_2\text{SO}_4$  for preparing  $\text{H}_2\text{O}_2$  from peroxides.



OR

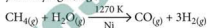
(i) **Protium** : Protium is the term used to represent  ${}^1_1\text{H}$ .

(ii) **Dihydrogen** : The diatomic molecule  $\text{H}_2$  is called dihydrogen.

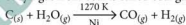
(iii) **Proton** : The ionised form of protium i.e.,  $\text{H}^+$  is called a proton.

(iv) **Hydron** : It is the general name referring to the positive ion of any hydrogen isotope.

11. Syn gas is a mixture of  $\text{CO}$  and  $\text{H}_2$  and also known as synthesis gas. Reaction of steam on hydrocarbons or coke at high temperatures in the presence of catalyst yields syn gas, e.g.,



Now a days syn gas is produced from sewage, saw-dust, scrapwood, news papers, etc. The process of production of syn gas from coal is called coal gasification.



12. Hydration is a phenomenon in which water molecules, being polar, surround an ion. This phenomenon is responsible for the dissolution of ionic solids in water and the formation of salt hydrates. On the other hand, hydrolysis is the reaction of a substance with water, e.g., one on account of which an aqueous solution of  $\text{FeCl}_3$  tests acidic or one in which  $\text{PBr}_3$  forms  $\text{H}_3\text{PO}_3$  and  $\text{HBr}$ .

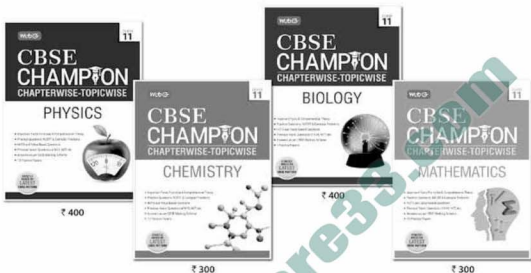
13. (i) The hydrides which do not possess sufficient number of valence electrons to form normal covalent bonds, are termed as electron deficient hydrides, examples are the hydrides of group 13 such as  $\text{BH}_3$ ,  $\text{AlH}_3$ , etc., they generally exist in polymeric forms.

(ii) The hydrides which possess exact number of electrons to form covalent bonds are termed electron precise hydrides. Examples are the hydrides of group 14 such as  $\text{CH}_4$ ,  $\text{SiH}_4$ ,  $\text{GeH}_4$ , etc.

(iii) The hydrides which have lone pair or pairs of electrons, i.e., have more electrons than required to form normal covalent bonds are termed electron rich

mtG

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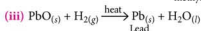
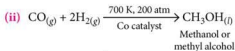
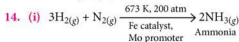
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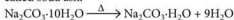
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hydrides. Examples are the hydrides of group 15, 16 and 17 such as  $\text{NH}_3$ ,  $\text{H}_2\text{O}$ ,  $\text{HF}$ , etc.



15. Sodium carbonate is a white crystalline solid which exists as decahydrate,  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ . This is also called washing soda. It is readily soluble in water. On heating, the decahydrate loses its water of crystallization to form monohydrate. Above 375 K, the monohydrate becomes completely anhydrous and changes to a white powder called soda ash.



16. (i) Sodium being highly electropositive element reacts vigorously with water evolving hydrogen which also catches fire. As a result, the fire spreads.

(ii) Alkali metals possess  $ns^1$  configuration, i.e., one unpaired electron is present and hence are paramagnetic. But in alkali metal salts, the unpaired electron is transferred to the non-metallic atom and both cations and anions have paired electrons and hence, alkali metal salts are diamagnetic in nature.

(iii) Superoxides contain the ion,  $\text{O}_2^-$  which has three electron bond, i.e., one unpaired electron is present and hence are paramagnetic. Normal oxides contain the ion  $\text{O}^{2-}$ , which does not have unpaired electron and thus, are diamagnetic in nature.

17. Molar mass of  $\text{H}_2\text{O}_2 = 34 \text{ g mol}^{-1}$

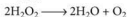
1 L of 5 M solution of  $\text{H}_2\text{O}_2$  will contain  $\text{H}_2\text{O}_2 = 34 \times 5 \text{ g}$

2 L of 5 M solution of  $\text{H}_2\text{O}_2$  will contain  $\text{H}_2\text{O}_2$

$$= 2 \times 34 \times 5 = 340 \text{ g}$$

200 mL of 5 M solution will contain  $\text{H}_2\text{O}_2$

$$= \frac{340}{2000} \times 200 = 34 \text{ g}$$



68 g of  $\text{H}_2\text{O}_2$  on decomposition will give  $\text{O}_2 = 32 \text{ g}$

$\therefore$  34 g of  $\text{H}_2\text{O}_2$  on decomposition will give  $\text{O}_2$

$$= \frac{32}{68} \times 34 = 16 \text{ g}$$

18. (i) **Caustic soda** : It is the commercial name of  $\text{NaOH}$ . It is used

(a) in refining of petroleum.

(b) in the manufacture of soap, paper, rayon, drugs and dyes.

(ii) **Sodium carbonate** : It is used

(a) in laundries and in softening of hard water as washing soda.

(b) in the manufacture of glass, sodium phosphate, paper, borax, caustic soda, etc.

(iii) **Quick lime** : It is used

(a) in the purification of sugar, manufacture of dye stuffs, bleaching powder,  $\text{CaC}_2$ , mortar, cement, glass, etc.

(b) as a flux in metallurgy.

19. Let the normality of  $\text{H}_2\text{O}_2$  soln. be  $N_x$ .

20 mL 0.1 N  $\text{Na}_2\text{S}_2\text{O}_3 = 20 \text{ mL}$  0.1 N  $\text{I}_2$

$= 25 \text{ mL } N_x \text{ H}_2\text{O}_2$

$$\text{Normality of } \text{H}_2\text{O}_2, N_x = \frac{20 \times 0.1}{25} = \frac{2}{25} = 0.08$$

$$\text{Strength} = \text{Eq. mass} \times \text{normality} \\ = 17 \times 0.08 = 1.36 \text{ g L}^{-1}$$

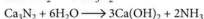
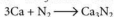
$$\text{Percentage} = \frac{1.36 \times 100}{1000} = 0.136\%$$

$$\text{Volume strength} = 5.6 \times \frac{\% \text{ Strength}}{\text{Eq. wt of } \text{H}_2\text{O}_2} \times 10 \\ = 5.6 \times \frac{0.136}{17} \times 10 = 0.448$$

20. As the size of the ion increases as we move down the group, the stability decreases and the reactivity increases. Since the charge/radius ratio of  $\text{Li}^+$  is similar to  $\text{Mg}^{2+}$ , this accounts for the similarities of  $\text{Li}^+$  with  $\text{Mg}^{2+}$  chemistry and differences with the rest of members of the group.

OR

$\text{A} = \text{NH}_3$  and  $\text{B} = \text{CaCO}_3$



(A)



(B)

21. (i)  $\text{Cr}(\text{OH})_3$  is converted into yellow coloured  $\text{Na}_2\text{CrO}_4$  when treated with  $\text{H}_2\text{O}_2$  in presence of  $\text{NaOH}$ .  
 $2\text{Cr}(\text{OH})_3 + 4\text{NaOH} + 3\text{H}_2\text{O}_2 \longrightarrow 2\text{Na}_2\text{CrO}_4 + 8\text{H}_2\text{O}$

(ii) Hydrazine is oxidised to  $\text{N}_2$  and  $\text{H}_2\text{O}$



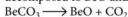
(iii)  $\text{H}_2\text{O}_2$  oxidises benzene to phenol in alkaline medium.



**22. (i)** The large amount of energy required to convert an  $N_2$  molecule into two  $N^{3-}$  ions can be thermodynamically achieved mainly through the lattice enthalpy of the metal nitride. Among the alkali metals, Li has the smallest ionic ( $Li^+$ ) size and hence the lattice enthalpy of its nitride is high enough to meet the thermodynamic requirement of the direct combination between the metal and nitrogen.

**(ii)** As  $F^-$  is smaller than  $Cl^-$ , LiF has a higher lattice enthalpy than LiCl. So, the LiCl lattice can be broken more easily than the LiF lattice by hydration. Because of its larger size,  $Cl^-$  is polarized more than  $F^-$  by  $Li^+$  and so LiCl is more covalent and more soluble in organic solvents than LiF.

**23. (i)** Beryllium carbonate is unstable and gets decomposed to BeO and  $CO_2$ .



When  $BeCO_3$  is stored in the atmosphere of  $CO_2$ , the concentration of  $CO_2$  increases in the right side, making the reaction to shift towards backside, hence decomposition of  $BeCO_3$  is prevented.

**(ii)** Beryllium chloride is an electron deficient molecule since Be has only two covalent bonds and hence only four electrons in the valence shell. Therefore, to complete its octet, it can accept two electron pairs from Cl atoms of neighbouring molecules forming polymeric structure. Thus, beryllium chloride has polymeric structure due to its electron deficient nature.

**(iii)** Gypsum ( $CaSO_4 \cdot 2H_2O$ ) is added in the final stages of preparation of cement since when  $H_2O$  is added to cement it slows down the process of setting of cement so that it gets sufficiently hardened thereby imparting greater strength to it.

**24. (i)** Conc.  $H_2SO_4$  reacts with zinc to form  $SO_2$  rather than  $H_2$ .



**(ii)** Ordinary  $H_2$  is less reactive and hence it does not reduce acidified  $FeCl_3$  solution. However, when zinc is added to acidified  $FeCl_3$  solution, nascent hydrogen thus produced is associated with more energy. Consequently, it is more reactive and hence reduces acidified  $FeCl_3$  solution.

**(iii)** Hard water on boiling forms precipitates of  $MgCO_3$ ,  $CaCO_3$  and  $CaSO_4$  which form scales in the boilers. As a result of these scales in the boilers, the boiler gets deteriorated due to over heating. Moreover, these scales are non-conducting and therefore, more fuel is consumed. Therefore, in order to prevent the formation of scales, hard water is softened before using in boilers.

**25. (i)** s-block contains only two groups; group 1 (alkali metals) and group 2 (alkaline earth metals.)

**(ii)** The electrode potential, i.e., reduction potential of Na (-2.71 V) or K (-2.92 V) is much lower than that of  $H_2O$  (-0.83 V), therefore, upon electrolysis, water gets reduced in preference to  $Na^+$  or  $K^+$  ions.

**(iii)** This is due to abnormal increase in the atomic size of potassium.

**(iv)** Alkali metals have only one valence electron per metal atom. As a result, the binding energy of alkali metal ions in the close packed metal lattices are weak. Therefore, these are soft and have low melting points.

**(v)**  $K + O_2 \rightarrow KO_2$ , potassium superoxide will be formed.

### OR

Alkali metals	Alkaline earth metals
<b>(i)</b> All alkali metals except Li form ionic compounds	<b>(i)</b> All alkaline earth metals except Be form ionic compounds.
<b>(ii)</b> The solubility of oxides of alkali metals increase down the group.	<b>(ii)</b> The solubility of oxides of Mg, Ca, Sr and Ba increase from Mg to Ba. $BeO$ , however, is, covalent and insoluble in water.
The basic character of the oxides increases down the group.	The basic character of oxides increases from MgO to $BaO$ . $BeO$ is, however, amphoteric.
<b>(iii)</b> All alkali metals form oxo salts such as carbonates, sulphates and nitrates.	<b>(iii)</b> All alkaline earth metals form oxo salts such as carbonates sulphates and nitrates.
<b>(iv)</b> Solubility of carbonates and sulphates increases down the group.	<b>(iv)</b> Solubility of carbonates and sulphates decreases down the group.
<b>(v)</b> Carbonates and sulphates of Li decompose on heating while the stability of carbonates and sulphates of other metals increases down the group.	<b>(v)</b> The carbonates and sulphates of alkaline earth metals decompose on heating but the temperature of their decomposition increases down the group, i.e., their thermal stability increases.

26. (i) (a)  $\text{LiH} < \text{NaH} < \text{CsH}$

Ionic character increases down a group.

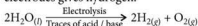
(b)  $\text{BeH}_2 < \text{CaH}_2 < \text{TiH}_4$

$\text{TiH}_4$  is a metallic hydride and its electrical conductance is only a little less than that of the metal.  $\text{CaH}_2$  is more ionic than  $\text{BeH}_2$  as the ionic character of the hydrides of representative elements increases down the group and so does the conductance.

(c)  $\text{MgH}_2 < \text{CaH}_2 < \text{NaH}$

The reducing power of the hydrides of representative element increases down a group and decreases from left to right in a period.

(ii) Electrolysis of acidified water using platinum electrodes gives hydrogen.



Here, the role of an electrolyte is to make water conducting.

OR

(i)  $\text{H}_2\text{O}_2$  acts as a bleaching agent due to the release of nascent oxygen.



Colouring matter +  $[\text{O}] \rightarrow$  Colourless matter

(Bleached)

(ii) Heavy water is  $\text{D}_2\text{O}$ .

Molecular weight :  $(2 \times 2) + 16 = 20$

(iii) Heavy water is used in the production of fertilisers, so it is often seen that heavy water plants are near to fertiliser industry. As the plants are near, the cost of transportation gets reduced and use of heavy water can be proper without any wastage.

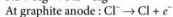
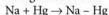
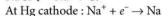
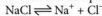
(iv) Sodium hexametaphosphate  $(\text{NaPO}_3)_6$  is calgon. The addition of calgon to hard water causes the calcium and magnesium ions of hard water to displace sodium ions from the anion of calgon. This results in removal of  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  from hard water.

(v) Water is used to extinguish most of the fires because it lowers the temperature of burning material. However, in case of petrol fires, petrol being lighter than water, floats over water and hence, fire spreads instead of being extinguished.

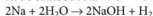
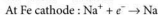
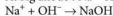
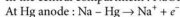
27. (i)  $\text{NaOH}$  is manufactured by the electrolysis of aqueous solution of  $\text{NaCl}$  in a Castner-Kellner cell. The cell consists of an iron tank divided into three compartments with the help of slate partitions which rest in  $\text{Hg}$ . A number of iron rods dipped in very dilute  $\text{NaOH}$  solution, placed in the central compartment, act as the cathode. The outer compartments contain  $\text{NaCl}$  solution and two graphite anodes are fixed in these compartments. A mercury layer serves as an intermediate electrode. Mercury is made to move from

one compartment to the other by application of rocking motion to the cell with the help of an eccentric wheel.

In the outer compartments :

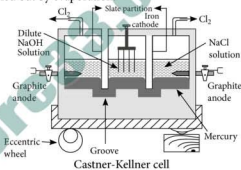


In the central compartment :  $\text{NaOH} \rightleftharpoons \text{Na}^+ + \text{OH}^-$



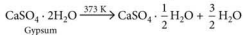
Thus,  $\text{Cl}_2$  is evolved at anode and  $\text{H}_2$  at cathode. The concentration of  $\text{NaOH}$  in the central compartment will go on increasing. When about 20% solution is formed, it is withdrawn and fresh dilute solution of  $\text{NaOH}$  is added. The further concentration of  $\text{NaOH}$  can be carried out by evaporation.

(ii)



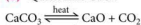
OR

(i) (a) Plaster of Paris  $\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$  :



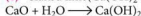
It is used for immobilising the affected bone during bone fracture or sprain.

(b) Quick lime  $\text{CaO}$  :



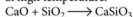
It is used as primary material for manufacture of cement.

(c) Slaked lime  $(\text{Ca}(\text{OH})_2)$  :



It is used in white wash.

(ii) Being a basic oxide, it combines with acidic oxides at high temperature.



(iii) (a) All enzymes that utilise ATP in phosphate transfer require magnesium as the cofactor.

(b) The main pigment for the absorption of light in plants is chlorophyll which contains magnesium.

Class XI

# MONTHLY TUNE UP!



## PRACTICE PROBLEMS

These practice problems enable you to self analyse your extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Performance analysis table given at the end will help you to check your readiness.

## Equilibrium

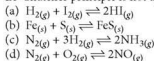
Total Marks : 120

Time Taken : 60 Min.

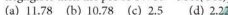
NEET / AIIMS

Only One Option Correct Type

1. Le-Chatelier principle is not applicable to



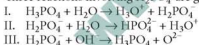
2. If first dissociation of  $\text{X}(\text{OH})_3$  is 100% whereas second dissociation is 50% and third dissociation is negligible then the pH of  $4 \times 10^{-3} \text{ M X}(\text{OH})_3$  is.



3.  $K_c$  for  $\text{A} + \text{B} \rightleftharpoons \text{C} + \text{D}$  is 10 at  $25^\circ\text{C}$ . If a container contains 1, 2, 3, 4 mol per litre of A, B, C, and D respectively at  $25^\circ\text{C}$ , the reaction shall

- (a) proceed from left to right  
 (b) proceed from right to left  
 (c) be at equilibrium (d) none of these.

4. Three reactions involving  $\text{H}_3\text{PO}_4$  are given below :



In which of the above does  $\text{H}_2\text{PO}_4^-$  act as an acid?

- (a) II only (b) I and II only  
 (c) III only (d) I only

5. For the reaction,  $\text{A} \rightleftharpoons \text{B}$ , the rate of disappearance of A at two temperature is given by

I.  $-\frac{d[\text{A}]}{dt} = 2 \times 10^{-2} [\text{A}] - 4 \times 10^{-3} [\text{B}]$  at  $300 \text{ K}$

II.  $-\frac{d[\text{A}]}{dt} = 4 \times 10^{-2} [\text{A}] - 16 \times 10^{-4} [\text{B}]$  at  $400 \text{ K}$

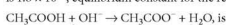
The heat of reaction for the change is

- (a) 3.863 kcal (b) 6.93 kcal  
 (c) 1.68 kcal (d)  $1.68 \times 10^2$  kcal

6. Sulphur ion in alkaline solution reacts with solid sulphur to form polysulphide ions having formulae  $\text{S}_2^{2-}$ ,  $\text{S}_3^{2-}$ ,  $\text{S}_4^{2-}$  and so on. The equilibrium constant for the formation of  $\text{S}_2^{2-}$  is 12 and for the formation of  $\text{S}_3^{2-}$  is 130, both from  $\text{S}$  and  $\text{S}^{2-}$ . What is the equilibrium constant for the formation of  $\text{S}_3^{2-}$  from  $\text{S}_2^{2-}$  and  $\text{S}$ ?

- (a) 10.8 (b) -0.092  
 (c) 15.60 (d) None of these

7. If equilibrium constant of the reaction,  $\text{CH}_3\text{COOH} + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{COO}^- + \text{H}_3\text{O}^+$  is  $1.8 \times 10^{-5}$ , equilibrium constant for the reaction,



- (a)  $1.8 \times 10^{-9}$  (b)  $1.8 \times 10^9$   
 (c)  $5.55 \times 10^{-10}$  (d)  $5.55 \times 10^{10}$

8. 15 moles of  $\text{H}_2$  and 5.2 moles of  $\text{I}_2$  are mixed and allowed to attain equilibrium at  $500^\circ\text{C}$ . At equilibrium, the concentration of HI is found to be 10 moles. The equilibrium constant for the formation of HI is

- (a) 50 (b) 15 (c) 100 (d) 25

9. The  $K_{sp}$  of  $\text{PbCO}_3$  and  $\text{MgCO}_3$  are  $1.5 \times 10^{-15}$  and  $1 \times 10^{-15}$  respectively at  $298 \text{ K}$ . The concentration of  $\text{Pb}^{2+}$  ions in a saturated solution containing  $\text{MgCO}_3$  and  $\text{PbCO}_3$  is

- (a)  $1.5 \times 10^{-4} \text{ M}$  (b)  $3 \times 10^{-8} \text{ M}$   
 (c)  $2 \times 10^{-8} \text{ M}$  (d)  $2.5 \times 10^{-8} \text{ M}$



10.  $K_b$  for  $\text{CH}_2\text{ClCOO}^-$  is  $7.41 \times 10^{-12}$ . The pH of 0.1 M  $\text{CH}_2\text{ClCOONa}$  in water is  
(a) 7.93 (b) 6.66 (c) 1.94 (d) 12.06
11. Which will have pH closer to 1.0?  
(a) 100 mL of 0.1 M HCl + 100 mL 0.1 M NaOH  
(b) 55 mL of 0.1 M HCl + 45 mL of 0.1 M NaOH  
(c) 10 mL of 0.1 M HCl + 90 mL of 0.1 M NaOH  
(d) 75 mL of 0.2 M HCl + 25 mL of 0.2 M NaOH
12. One mole of  $\text{N}_2\text{O}_{4(g)}$  at 300 K is kept in a closed container under one atmosphere. It is heated to 600 K when 20% by mass of  $\text{N}_2\text{O}_{4(g)}$  decomposes to  $\text{NO}_{2(g)}$ . The resultant pressure is  
(a) 1.2 atm (b) 2.4 atm (c) 2.0 atm (d) 1.0 atm

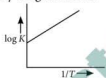
### Assertion & Reason Type

**Directions :** In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

- (a) If both assertion and reason are true and reason is the correct explanation of assertion.  
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.  
(c) If assertion is true but reason is false.  
(d) If both assertion and reason are false.

13. **Assertion:** The graph of  $\log K$  and  $\frac{1}{T}$  for endothermic process is shown by the given curve:

**Reason :** For endothermic process, on increasing temperature the value of equilibrium constant increases monotonically.

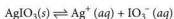


14. **Assertion:** The  $[\text{H}^+]$  for both 0.05 M acetic acid and 0.05 N acetic acid solution are same.  
**Reason :**  $K_a$  is a dimensionless quantity.
15. **Assertion:** A very dilute acidic solution of  $\text{Cd}^{2+}$  and  $\text{Ni}^{2+}$  gives yellow precipitate of CdS on passing hydrogen sulphide.  
**Reason :** Solubility product of CdS is more than that of NiS.

### JEE MAIN / ADVANCED

#### Only One Option Correct Type

16. The equilibrium constant  $K_{p1}$  and  $K_{p2}$  for the reactions  $\text{X} \rightleftharpoons 2\text{Y}$  and  $\text{Z} \rightleftharpoons \text{P} + \text{Q}$ , respectively, are in the ratio of 1 : 9. If the degree of dissociation of X and Z be equal, then the ratio of total pressures at these equilibria is  
(a) 1 : 36 (b) 1 : 1 (c) 1 : 3 (d) 1 : 9
17. In a saturated solution of the sparingly soluble strong electrolyte  $\text{AgIO}_3$  (molecular mass = 283) the equilibrium which sets in is



If the solubility product constant  $K_{sp}$  of  $\text{AgIO}_3$  at a given temperature is  $1.0 \times 10^{-8}$ , what is the mass of  $\text{AgIO}_3$  contained in 100 mL of its saturated solution?

- (a)  $2.83 \times 10^{-2}$  g (b)  $2.83 \times 10^{-3}$  g  
(c)  $1.0 \times 10^{-7}$  g (d)  $1.0 \times 10^{-4}$  g
18. Assume that the decomposition of  $\text{HNO}_3$  can be represented by the following equation  
$$4\text{HNO}_{3(g)} \rightleftharpoons 4\text{NO}_{2(g)} + 2\text{H}_2\text{O}_{(g)} + \text{O}_{2(g)}$$
and the reaction approaches equilibrium at 400 K and 30 atm. At equilibrium partial pressure of  $\text{HNO}_3$  is 2 atm. Calculate  $K_p$  in  $(\text{mol/L})^3$  at 400 K.  
(Use:  $R = 0.08 \text{ atm-L/mol-K}$ )  
(a) 4 (b) 8 (c) 16 (d) 32
19.  $K_c$  for the reaction,  $[\text{Ag}(\text{CN})_2]^- \rightleftharpoons \text{Ag}^+ + 2\text{CN}^-$ , at  $25^\circ\text{C}$  is  $4.0 \times 10^{-19}$ , then the silver ion concentration in solution which was originally 0.1 molar in KCN and 0.03 molar in  $\text{AgNO}_3$  is  
(a)  $7.5 \times 10^{-18}$  (b)  $7.5 \times 10^{-18}$   
(c)  $7.5 \times 10^{-19}$  (d)  $7.5 \times 10^{-19}$

#### More than One Options Correct Type

20. A vessel at 1000 K contains  $\text{CO}_2$  with a pressure of 0.5 atm. Some of the  $\text{CO}_2$  is converted into CO on adding graphite. The total pressure at equilibrium was found to be 0.8 atm. Which of the following is/are correct?  
(a) The equilibrium is achieved as soon as  $Q = K$ , when  $K = 0.18 \text{ atm}^2$ .  
(b) The equilibrium is achieved as soon as  $Q = K$ , when  $K = 1.8 \text{ atm}$ .  
(c) The  $p_{\text{CO}_2} = 0.2 \text{ atm}$  at equilibrium.  
(d) The  $p_{\text{CO}} = 0.6 \text{ atm}$  at equilibrium.
21. Which of the following statement(s) is (are) correct?  
(a) The pH of  $1.0 \times 10^{-8}$  M solution of HCl is 8.  
(b) The conjugate base of  $\text{H}_2\text{PO}_4^-$  is  $\text{HPO}_4^{2-}$ .  
(c) Autoprotolysis constant of water increases with temperature.  
(d) When a solution of a weak monoprotic acid is titrated against a strong base, at half neutralisation point  $\text{pH} = (1/2) \text{p}K_a$ .
22. The exothermic formation of  $\text{ClF}_3$  is represented by the equation:  
$$\text{Cl}_{2(g)} + 3\text{F}_{2(g)} \rightleftharpoons 2\text{ClF}_{3(g)}; \Delta H = -329 \text{ kJ mol}^{-1}$$
Which of the following will increase the quantity of  $\text{ClF}_3$  in an equilibrium mixture of  $\text{Cl}_2$ ,  $\text{F}_2$  and  $\text{ClF}_3$ ?  
(a) Decreasing the temperature  
(b) Removing  $\text{Cl}_2$   
(c) Increasing the volume of the container  
(d) Adding  $\text{F}_2$

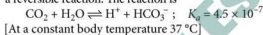
23. A reaction  $S_{8(g)} \rightleftharpoons 4S_{2(g)}$  is carried out by taking 2 moles of  $S_{8(g)}$  and 0.2 mole of  $S_{2(g)}$  in a reaction vessel of one litre at 627 °C. Which of the following statements are correct if  $K_c = 6.30 \times 10^{-6}$ ?
- Reaction quotient is  $8 \times 10^{-4}$ .
  - Reaction proceeds in backward direction.
  - $K_p = 2.55 \text{ atm}^3$ .
  - Reaction proceeds in forward direction.

#### Numerical Value Type

24. 250.0 mL of saturated clear solution of  $CaC_2O_{4(aq)}$  requires 6.3 mL of 0.00102 M  $KMnO_{4(aq)}$  in acid medium for complete oxidation of  $C_2O_4^{2-}$  ions. The  $K_{sp}$  of  $CaC_2O_4$  is
25. At 273 K and one atm, 'a' litre of  $N_2O_4$  decomposes to  $NO_2$  according to equation  $N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$ . To what extent (%) has the decomposition proceeded when the original volume is 25% less than that of existing volume?
26. The pH at which  $Mg(OH)_2$  begins to precipitate from a solution containing 0.10 M  $Mg^{2+}$  ions is  $[K_{sp} Mg(OH)_2 = 1.0 \times 10^{-11}]$

#### Comprehension Type

The pH of blood is 7.4. pH of blood should be maintained constant, otherwise it may cause illness like increase of blood pressure or decrease of blood pressure. The buffer in the blood is formed by  $CO_2$  and  $HCO_3^-$  ion. The reaction available in the blood is a reversible reaction. The reaction is



27. What would be the effect of the rapid forced breathing?
- Increase the concentration of  $CO_2$
  - Lower the concentration of  $CO_2$
  - Equilibrium constant increases
  - Equilibrium constant decreases
28. Calculate the ratio of the concentration of conjugate base to acid necessary to maintain blood at its proper pH.
- 4.5
  - 3.75
  - 11.25
  - 14

#### Matrix Match Type

29. Match the column I with column II and choose the correct answer using the codes given below : (Given  $K_{sp}$  of  $AgCl = 10^{-10}$  and  $K_{sp}$  of  $Ag_2SO_4 = 4 \times 10^{-15}$ )

##### Column I

##### Column II

- |  |   |
|--|---|
| (P) Solubility of $AgCl$ in water (saturated solution) | (1) $10^{-5} \text{ M}$                 |
| (Q) Solubility of $Ag_2SO_4$ in water                  | (2) $1.435 \times 10^{-6} \text{ g/mL}$ |
| (R) Solubility of $Ag_2SO_4$ in 0.1 M $AgNO_3$         | (3) $4 \times 10^{-13} \text{ M}$       |
| (S) Solubility of $Ag_2SO_4$ in 0.1 M $Na_2SO_4$       | (4) $10^{-7} \text{ M}$                 |

##### Codes :

- | P        | Q | R | S | P        | Q | R | S |
|----------|---|---|---|----------|---|---|---|
| (a) 1, 2 | 2 | 4 | 3 | (b) 1, 2 | 1 | 3 | 4 |
| (c) 1, 3 | 1 | 2 | 4 | (d) 1, 2 | 1 | 4 | 3 |

30. Match the column I with column II and choose the correct answer using the codes given below :

##### Column I (Reactions)

##### Column II (Favourable conditions)

- |  |  |
|--|--|
| (P) Formation of $NO_{2(g)}$ :<br>$NO_{(g)} + O_{3(g)} \rightleftharpoons NO_{2(g)} + O_{2(g)} + 200 \text{ kJ}$         | (1) Increase in temperature                    |
| (Q) Oxidation of $NH_{3(g)}$ :<br>$4NH_{3(g)} + 5O_{2(g)} \rightleftharpoons 4NO_{(g)} + 6H_2O_{(g)} + 905.6 \text{ kJ}$ | (2) Decrease in temperature                    |
| (R) Dissociation of $N_2O_{4(g)}$ :<br>$N_2O_{4(g)} + 57.2 \text{ kJ} \rightleftharpoons 2NO_{2(g)}$                     | (3) Decrease in pressure                       |
| (S) Oxidation of nitrogen :<br>$N_{2(g)} + O_{2(g)} + 180.5 \text{ kJ} \rightleftharpoons 2NO_{(g)}$                     | (4) Addition of inert gas at constant pressure |

##### Codes :

- | P       | Q     | R     | S   |
|---------|-------|-------|-----|
| (a) 1   | 2,3,4 | 1,3   | 1,4 |
| (b) 2   | 1,3,4 | 2,3   | 2   |
| (c) 2,4 | 1,3,4 | 1,4   | 2,4 |
| (d) 2   | 2,3,4 | 1,3,4 | 1   |



Keys are published in this issue. Search now! ☺

## CHECK YOUR PERFORMANCE

No. of questions attempted	.....	If your score is	
No. of questions correct	.....	> 80%	Your preparation is going good, keep it up to get high score.
Marks scored in percentage	.....	60-80%	Need more practice, try hard to score more next time.
		<60%	Stress more on concepts and revise thoroughly.

# FOCUS

Class  
XII

# NEET/JEE 2019

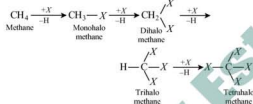
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## UNIT - 5 : Haloalkanes & Haloarenes | Alcohols, Phenols & Ethers

### HALOALKANES AND HALOARENES

#### HALOALKANES (ALKYL HALIDES)

- Compounds in which one or more hydrogen of alkane is (are) replaced by halogen are known as haloalkanes.



#### Nomenclature

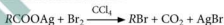
- According to common or trivial system, monohaloderivatives are named as alkyl halides. e.g.,  $\text{CH}_3-\text{Cl}$  (methyl chloride)
- According to IUPAC system, the monohaloderivatives of alkanes are named as haloalkanes. e.g.,  $\text{CH}_3-\underset{\text{Br}}{\text{CH}}-\text{CH}_3$  (2-bromopropane)

#### Preparation

- From alcohols:
 

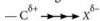
R-OH	$\text{PCl}_5$	$\rightarrow \text{RCl} + \text{POCl}_3 + \text{HCl}$
	HCl, anhyd. $\text{ZnCl}_2$	$\rightarrow \text{RCl} + \text{H}_2\text{O}$
	$\text{SOCl}_2$	$\rightarrow \text{RCl} + \text{SO}_2\uparrow + \text{HCl}\uparrow$
	$\text{PI}_3$	$\rightarrow \text{RI} + \text{H}_3\text{PO}_3$

- Halogenation of alkanes:  $\text{R}-\text{H} + \text{X}_2 \xrightarrow{h\nu} \text{RX} + \text{HX}$
- Finkelstein reaction:  $\text{R}-\text{Cl} + \text{NaI} \xrightarrow{\text{Acetone}, \Delta} \text{RI} + \text{NaCl}$
- Hunsdiecker reaction:



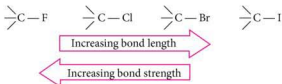
#### Nature of C—X Bond

- In haloalkanes, the halogen atom is bonded to an alkyl group. The carbon atom is  $sp^3$ -hybridised.
- The C—X bond is highly polarised covalent bond due to large difference in the electronegativities of carbon and halogen atoms. Halogen tends to pull the electrons away from carbon due to high electronegativity.



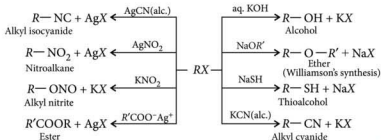
This positive charge on carbon makes it susceptible for nucleophilic attack.

- In haloalkanes bond strength of C—X bond decreases with an increase in bond length as one moves from fluorine to iodine.



## Chemical Properties

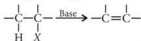
- Nucleophilic substitution reactions** : Alkyl halides easily undergo nucleophilic substitution reactions. Weakly basic halide ion is a good leaving group and gets replaced by other nucleophile easily.



- The nucleophilic substitution can proceed via  $S_N1$  mechanism or  $S_N2$  mechanism :

Unimolecular ( $S_N1$ )	Bimolecular ( $S_N2$ )
It is first order reaction.	It is second order reaction.
Generally carried out in polar protic solvents like water, alcohol and acetic acid.	Carried out in polar aprotic solvents like acetone, DMSO, acetonitrile, or DME.
Takes place in two steps through carbocation as the intermediate.	Takes place in one step through transition state.
Rate of reaction : $3^\circ > 2^\circ > 1^\circ > ^+CH_3$ (fastest) (slowest)	Rate of reaction : $CH_3 > 1^\circ > 2^\circ > 3^\circ$ halides (fastest) (slowest)
Greater the stability of carbocation, faster will be the reaction.	Lesser the steric hindrance in transition state, faster will be the reaction.
Tends to proceed with weak nucleophiles e.g., $CH_3OH$ , $H_2O$ , $CH_3CH_2OH$ , etc.	Tends to proceed with strong nucleophiles, e.g., $CH_3O^-$ , $CN^-$ , $OH^-$ , etc.
Configuration is retained but in front attack inversion takes place (racemisation and inversion).	Inversion of configuration takes place (Walden inversion).

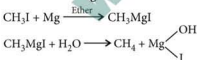
- Dehydrohalogenation :**



- Wurtz reaction :**



- Reaction with Mg metal :**



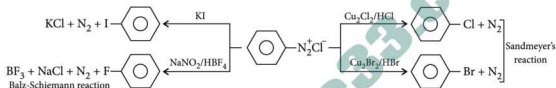
## Optical Rotation

- Substances which rotate the path of plane polarised light to either left or right are known as optically active and the rotation is known as optical rotation.

- If the substance rotates the plane polarised light in clockwise direction (i.e., to the right) it is called dextrorotatory or *d*-form and if the substance rotates the plane polarized light in anticlockwise direction (i.e., to the left), it is called laevorotatory or *l*-form.

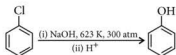
- The compounds which differ only in the behaviour towards polarised light are called optical isomers and the phenomenon is called optical isomerism.
- Alkyl halides show optical isomerism. Basic requirement for the presence of optical isomerism is
  - Compounds must have a chiral or asymmetric carbon atom i.e., a carbon atom should be linked to four different groups.
  - Mirror images must be non-superimposable (non superimposable mirror images are said to be enantiomers).

- **Diastereomers** : They are the optical isomers which are not mirror images of each other. They have different physical properties and magnitude of specific rotation.
- **Meso compounds** : These compounds have two or more even number of chiral carbon atoms and have an internal plane of symmetry. They are optically inactive due to internal compensation.
- Lowest molecular mass, optically active haloalkane must contain four carbon atom.



## Chemical Properties

- The aryl halides are relatively less reactive towards nucleophilic substitution reactions as compared to alkyl halides. This low reactivity can be attributed due to the following factors :
  - The C—X bond in halobenzene has a partial double bond character due to involvement of halogen electrons in resonance with benzene ring.
  - The C—X bond in aryl halides is less polar as compared to that in alkyl halides as  $sp^2$  hybridised carbon is more electronegative than  $sp^3$  hybridised carbon.
- **Nucleophilic substitution reactions** :

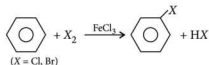


The presence of an electron withdrawing group ( $-\text{NO}_2$ ) at *ortho*- and *para*-positions increases the reactivity of haloarenes.

## HALOARENES

### Preparation

- **Direct halogenation of benzene (electrophilic substitution reactions)** :

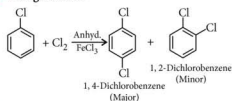


- **From benzene diazonium chloride** :

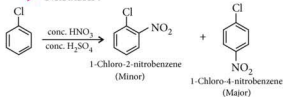


- **Electrophilic substitution reactions** :

- **Halogenation** :



- **Nitration** :



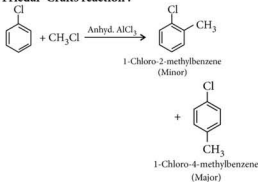
### MONTHLY TUNE UP CLASS XI

### ANSWER

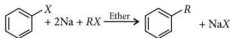
### KEY

- |                            |            |            |               |         |
|----------------------------|------------|------------|---------------|---------|
| 1. (b)                     | 2. (a)     | 3. (a)     | 4. (a)        | 5. (a)  |
| 6. (a)                     | 7. (b)     | 8. (a)     | 9. (b)        | 10. (a) |
| 11. (d)                    | 12. (b)    | 13. (a)    | 14. (b)       | 15. (c) |
| 16. (a)                    | 17. (b)    | 18. (d)    | 19. (b)       |         |
| 20. (b, c, d)              | 21. (b, c) | 22. (a, d) | 23. (a, b, c) |         |
| 24. ( $4 \times 10^{-3}$ ) | 25. (33)   | 26. (9)    | 27. (b)       |         |
| 28. (b)                    | 29. (b)    | 30. (d)    |               |         |

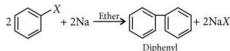
• **Friedal-Crafts reaction :**



• **Wurtz-Fittig Reaction :**



• **Fittig reaction :**



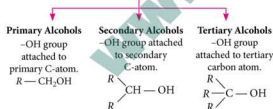
## ALCOHOLS, PHENOLS AND ETHERS

### ALCOHOLS

- **General formula :** Alcohols are the hydroxy derivatives of alkanes having general formula  $\text{C}_n\text{H}_{2n+1}\text{OH}$ .
- **Nomenclature :** In common system, alcohols are named as alkyl alcohol. According to IUPAC system, alcohols are called 'alkanols', by replacing '-e' of alkane by '-ol'.
- **Structure :** In alcohols,  $\text{R-OH}$ , the O atom of hydroxyl group is attached to C-atom by a sigma ( $\sigma$ ) bond formed by the overlap of  $sp^3$ -hybridised orbital of C-atom with  $sp^3$ -hybridised orbital of

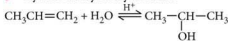


- Monohydric alcohols are of three types :  
**Monohydric alcohols**

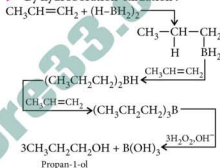


### Preparation

- **From alkenes :**
  - **By acid catalysed hydration :**

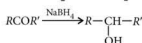
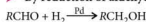


➤ **By hydroboration-oxidation :**



• **From carbonyl compounds :**

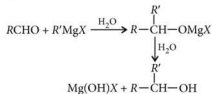
➤ **By reduction of aldehydes and ketones :**



➤ **By reduction of carboxylic acids and esters :**

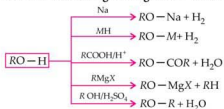


➤ **From Grignard reagents :**

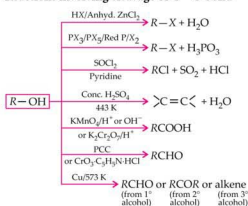


## Chemical Properties

- Reactions involving cleavage of O—H bond



- Reactions involving cleavage of C—O bond



## Identification Tests

- Lucas test :** Lucas reagent is a solution of conc. HCl with anhyd.  $\text{ZnCl}_2$ .  
With Lucas reagent : Primary alcohols (No cloudiness), Secondary alcohols (Cloudiness in 5 minutes), Tertiary alcohols (Cloudiness immediately).  
By this reaction it is clear that  $1^\circ$  alcohol is most acidic and  $3^\circ$  alcohol is most basic amongst alcohols.

- Victor Meyer's test :**

Primary alcohol	Secondary alcohol	Tertiary alcohol
$  \begin{array}{c}  \text{RCH}_2\text{OH} \\  \downarrow \text{P} + \text{I}_2 \\  \text{RCH}_2\text{—I} \\  \downarrow \text{AgNO}_3 \\  \text{RCH}_2\text{—NO}_2 \\  \downarrow \text{HNO}_2 \\  \text{R—C—NO}_2 \\  \parallel \\  \text{N—OH} \\  \text{Nitrolic acid} \\  \downarrow \text{NaOH} \\  \text{R—C—NO}_2 \\  \parallel \\  \text{N—O}^- \text{Na}^+ \\  \text{Red colour}  \end{array}  $	$  \begin{array}{c}  \text{R}_2\text{CHOH} \\  \downarrow \text{P} + \text{I}_2 \\  \text{R}_2\text{CH—I} \\  \downarrow \text{AgNO}_3 \\  \text{R}_2\text{CH—NO}_2 \\  \downarrow \text{HNO}_2 \\  \text{R—C—NO}_2 \\  \parallel \\  \text{N=O} \\  \text{Pseudonitrol} \\  \downarrow \text{NaOH} \\  \text{Blue colour}  \end{array}  $	$  \begin{array}{c}  \text{R}_3\text{C—OH} \\  \downarrow \text{P} + \text{I}_2 \\  \text{R}_3\text{C—I} \\  \downarrow \text{AgNO}_3 \\  \text{R}_3\text{C—NO}_2 \\  \downarrow \text{HNO}_2 \\  \text{No reaction} \\  \downarrow \text{NaOH} \\  \text{Colourless}  \end{array}  $

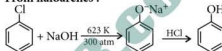
## PHENOLS

- General formula :** Phenols are the compounds in which hydroxy (—OH) group is directly linked to aromatic ring having formula  $\text{C}_6\text{H}_5\text{OH}$ .
- Nomenclature :** The simplest hydroxy derivative of benzene is phenol which is also called carboxylic acid. It is its common name and, which is also an accepted IUPAC name.
- Structure :** In phenols, the —OH group is attached to  $sp^2$ -hybridised C-atom of an aromatic ring.

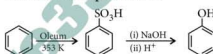


## Preparation

- From haloarenes :**



- From benzenesulphonic acid :**



- From diazonium salts :**

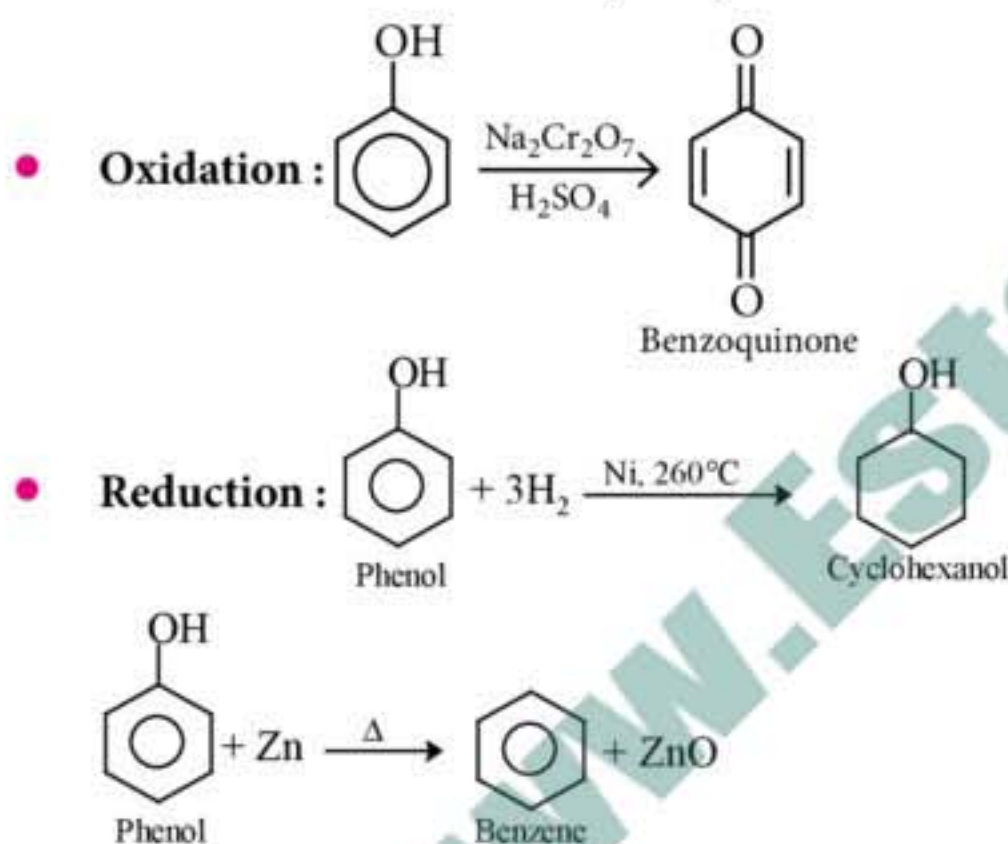
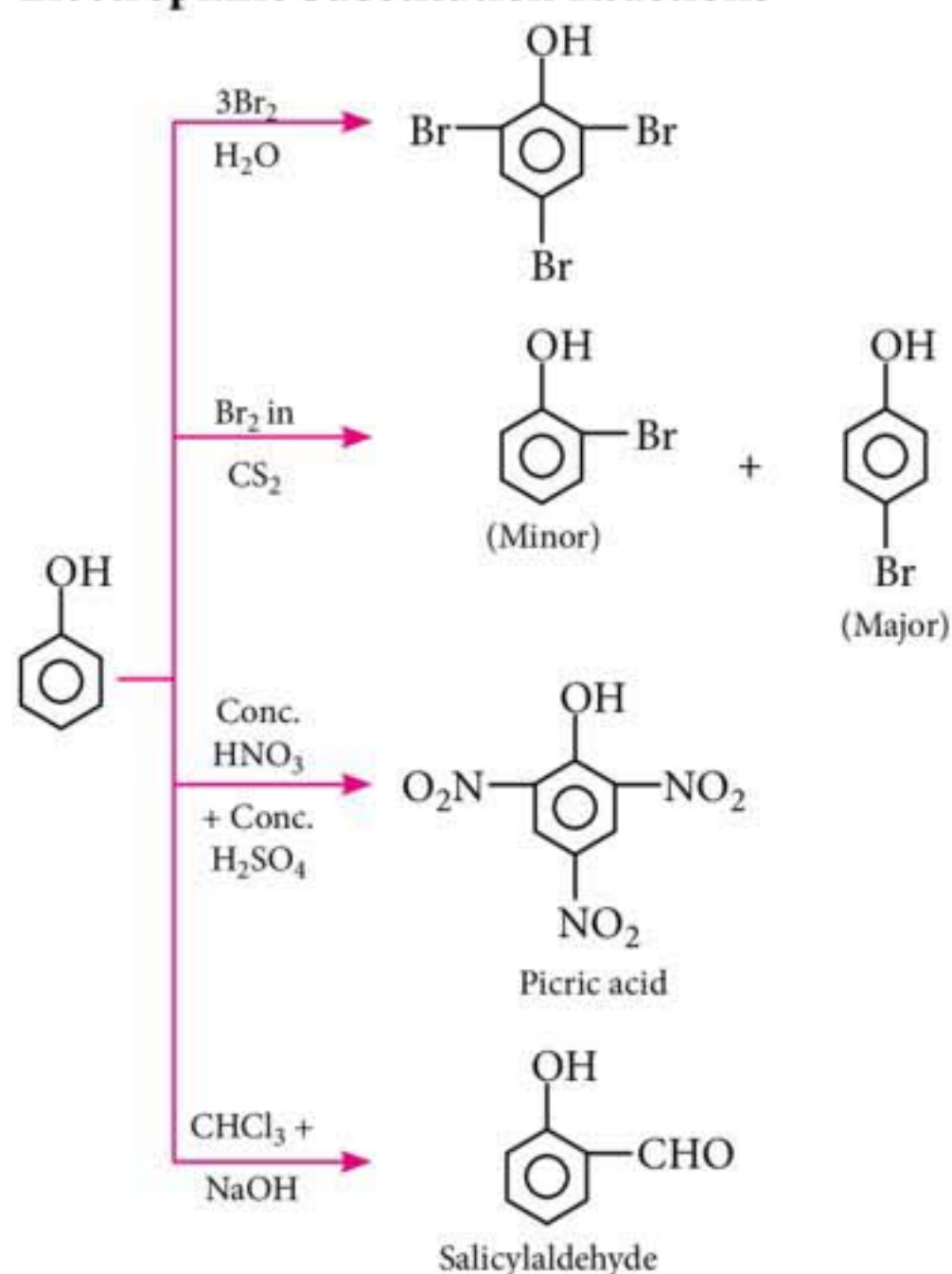


## Chemical Properties

- Acidity of phenols :** Phenols are weakly acidic in nature due to polar O—H bond directly attached to  $sp^2$ -hybridised C-atom.
  - They turn blue litmus red and react with alkali metals and alkalies to form their salts.
  - Phenol is weaker acid than carboxylic acid. It does not react with sodium carbonate ( $\text{Na}_2\text{CO}_3$ ) and sodium bicarbonate ( $\text{NaHCO}_3$ ).
  - Phenols are more acidic than alcohols which can be explained on the basis of resonance.
  - Electron withdrawing groups increase the acidic strength of phenols.
  - Electron releasing groups decrease the acidic strength of phenols.



## Electrophilic Substitution Reactions



## ETHERS

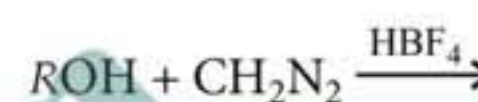
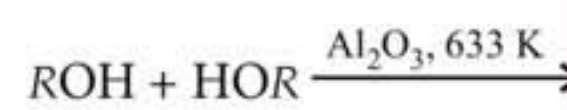
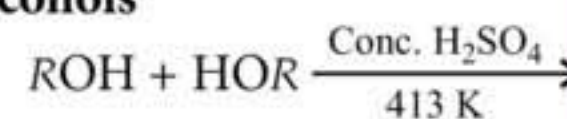
- General formula:** Ethers are the compounds having general formula  $\text{C}_n\text{H}_{2n+2}\text{O}$ ; where,  $n$  is always greater than 1.
- Nomenclature:** Common names of ethers are derived from the names of alkyl/aryl groups written as separate words in alphabetical order and adding the word 'ether' at the end. According to IUPAC system of nomenclature, ethers are regarded as hydrocarbon derivatives in which a hydrogen atom is replaced by an  $-\text{OR}$  or  $-\text{OAr}$  group, where  $R$  and  $\text{Ar}$  represent alkyl and aryl groups, respectively.

- Structure:** In ethers, the four electron pairs, i.e., the two bond pairs and two lone pairs of electrons on O-atom are arranged approximately in a tetrahedral arrangement.

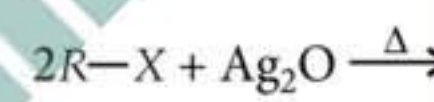


## Preparation

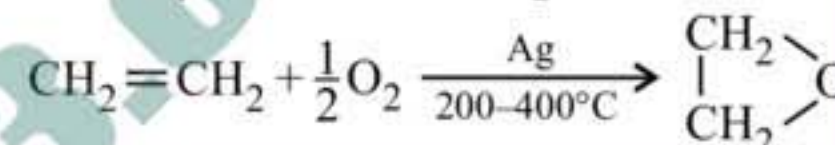
### By dehydration of alcohols



### From alkyl halides

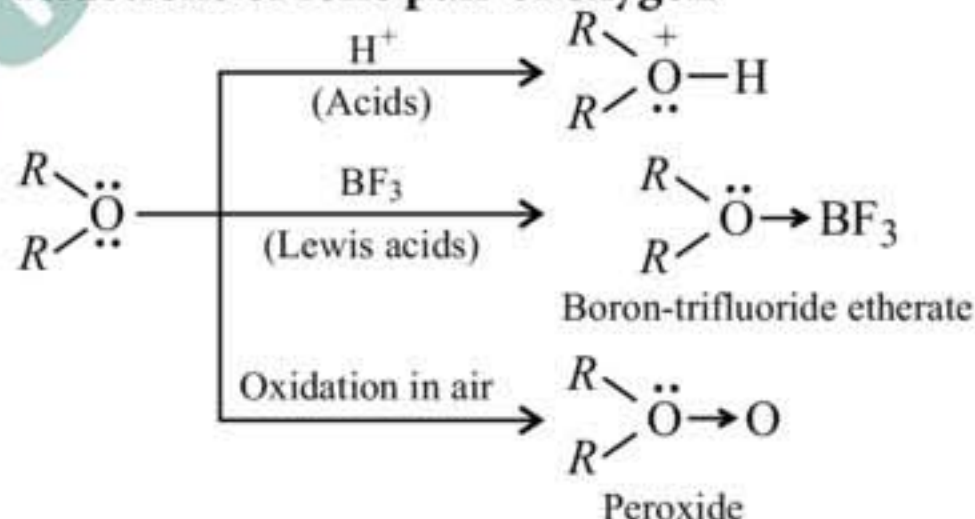


### Preparation of cyclic ethers (or epoxides)

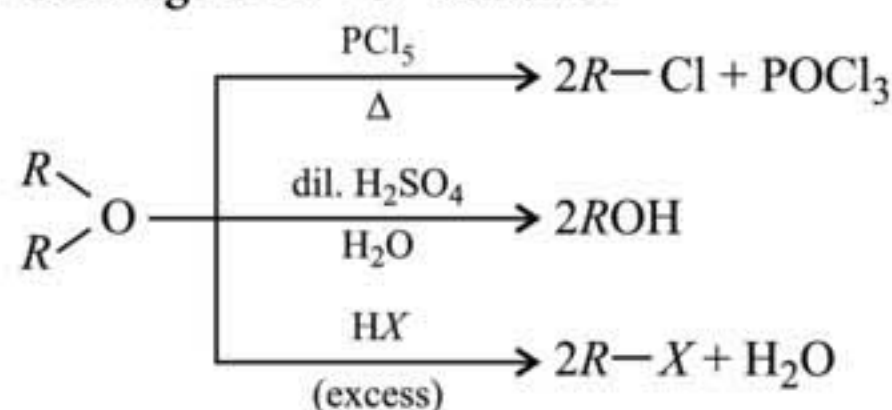


## Chemical Properties

### Reactions of lone pair of oxygen



### Cleavage of $\text{R-O-R}$ bond



## Quotable Quote

The greatest enemy of knowledge is not the ignorance, it is the illusion of knowledge.

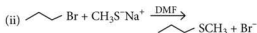
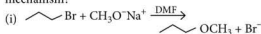
Stephen Hawking

<https://t.me/Estore33> com

- (a) one phenyl group is replaced by a methyl group  
 (b) one phenyl group is replaced by a *para*-methoxyphenyl group  
 (c) two phenyl groups are replaced by two *para*-methoxyphenyl groups  
 (d) no structural change is made to X.

(JEE Advanced 2018)

9. Which reaction is faster (i) or (ii) and what is its mechanism?

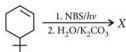


- (a) Reaction (i),  $S_N1$  (b) Reaction (ii),  $S_N2$   
 (c) Reaction (ii),  $S_N1$  (d) Reaction (i),  $S_N2$

10. The total number of acyclic isomers including stereoisomers with molecular formula  $C_4H_7Cl$  are

- (a) 9 (b) 10 (c) 11 (d) 12

11. The product of the reaction given below is



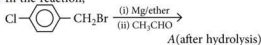
- (a) C1=CC=CC=C1 (b) Oc1ccccc1  
 (c) O=C1C=CC=CC1 (d) OC(=O)c1ccccc1

(JEE Main 2016)

12. Which of the following ether does not give peroxide?

- (a) CC(C)OC(C)C (b) C=CCOC1=CC=CC=C1  
 (c) c1ccc(cc1)Oc2ccc(cc2) (d) C1CCOC1

13. In the reaction,



The product A is

- (a) CC(O)(Cc1ccc(cc1))Cc2ccc(cc2)Cl

- (b) Clc1ccc(cc1)CC(C)(O)C  
 (c) CC(O)(Cc1ccc(cc1))Cc2ccc(cc2)C  
 (d) C=Cc1ccc(cc1)CCBr

14. Which one is the most acidic compound?

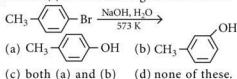
- (a) Oc1ccccc1 (b) Oc1ccc(cc1)[N+](=O)[O-]  
 (c) Oc1c([N+](=O)[O-])cc([N+](=O)[O-])cc1[N+](=O)[O-] (d) COc1ccc(cc1)[N+](=O)[O-]

(NEET 2017)

15. An ether (A)  $C_5H_{12}O$  when heated with excess HI produced two alkyl iodide which on alkaline hydrolysis forms compound (B) and (C). Oxidation of (B) gives acid and oxidation of (C) gives ketone. What is compound (A)?

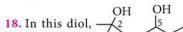
- (a)  $CH_3OCH_2CH_2CH_2CH_3$   
 (b)  $C_2H_5OCH_2CH_2CH_3$   
 (c)  $C_2H_5OCH(CH_3)_2$  (d) All of these

16. Product(s) of the following reaction can be



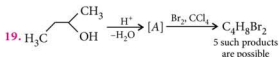
17. Which of the following reaction does not form ether?

- (a)  $RX + aq. KOH$  (b)  $RX + RONa$   
 (c)  $CH_2N_2 + ROH$   
 (d)  $ROH + conc. H_2SO_4$  at 413 K



- (a) OH at  $C_2$  is more basic than that of at  $C_5$   
 (b) OH at  $C_2$  is more acidic than at  $C_5$   
 (c) both behave as a base  
 (d) both behave as an acid.





How many structures of A are possible?

- (a) 2 (b) 5 (c) 6 (d) 3





20. Consider the following alkyl halides :

- I.  $(\text{CH}_3)_3\text{CBr}$  II.  $\text{CH}_3\text{Br}$   
 III.  $\text{C}_2\text{H}_5\text{Br}$  IV.  $\text{CH}_3\text{CHBrCH}_3$

Arrange these alkyl halides in decreasing order of reactivity in Williamson reaction.

- (a)  $\text{I} > \text{IV} > \text{III} > \text{II}$  (b)  $\text{I} > \text{II} > \text{III} > \text{IV}$   
 (c)  $\text{IV} > \text{III} > \text{II} > \text{I}$  (d)  $\text{II} > \text{III} > \text{IV} > \text{I}$

21. Which is hydrolysed at the fastest rate?

- (a)  (b)   
 (c)  (d) 

22. What happens when an oxirane is heated with  $\text{PCl}_5$ ?

- (a) A geminal dihalide is formed.  
 (b) A vicinal dihalide is formed.  
 (c) Mixture of vicinal and geminal dihalide is formed.  
 (d) No reaction takes place.

23. The molecular formula of diphenyl methane is  $\text{C}_{13}\text{H}_{12}$ . How many structural isomers are possible when one of the hydrogen is replaced by a chlorine atom?

- (a) 6 (b) 4 (c) 8 (d) 7



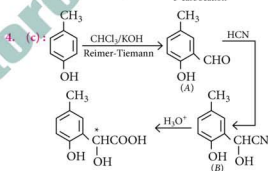
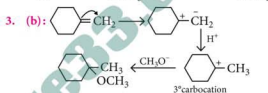
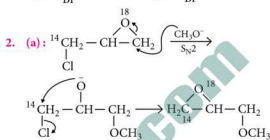
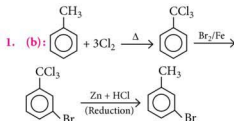
This reaction will be the fastest in

- (a) ethanol (b) methanol  
 (c)  $N,N'$ -dimethylformamide (DMF)  
 (d) water. (NEET Phase-II 2016)

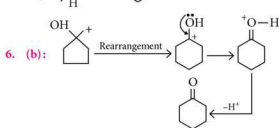
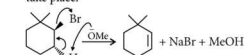
25. For which of the following parameters the structural isomers  $\text{C}_2\text{H}_5\text{OH}$  and  $\text{CH}_3\text{OCH}_3$  would be expected to have the same values? (Assume ideal behaviour)

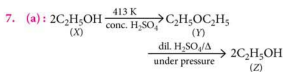
- (a) Heat of vaporisation  
 (b) Vapour pressure at the same temperature  
 (c) Boiling points  
 (d) Gaseous densities at the same temperature and pressure

## SOLUTIONS



5. (b): NaOMe is acting as a base thus it will cause abstraction of  $\text{H}^+$  ion. Thus,  $\text{E}_2$  elimination will take place.





8. (c)

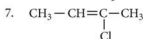
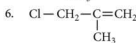
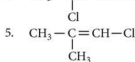
9. (d): Nucleophilicity (in DMF):  $\text{CH}_3\text{O}^- > \text{CH}_3\text{S}^-$

10. (d): 1.  $\text{CH}_3-\text{CH}_2-\text{CH}=\text{CH}-\text{Cl}$

2.  $\text{CH}_3-\text{CH}=\text{CH}-\text{CH}_2-\text{Cl}$

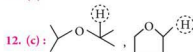
3.  $\text{Cl}-\text{CH}_2-\text{CH}_2-\text{CH}=\text{CH}_2$

4.  $\text{CH}_3-\text{CH}=\text{CH}=\text{CH}_2$



Compound 1, 2, 5, 7 shows geometrical isomers. Compound 4 shows optical isomerism.

11. (b)

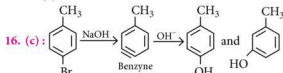
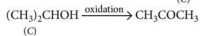
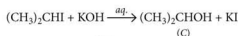
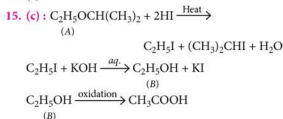


and have oxidisable H. The "H"

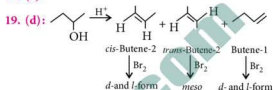
attach to C which is directly linked to O is oxidisable.



14. (c)

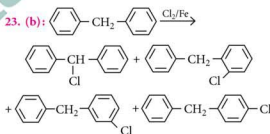
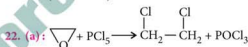
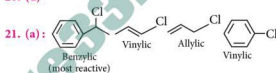


18. (a)



Thus, we find 3 possible structures of A.

20. (d)



24. (c)

25. (d): Vapour density =  $\frac{\text{Molecular weight}}{2}$

As both the compounds have same molecular weights, both will have the same vapour density. Hence, gaseous density of both ethanol and dimethyl ether would be same under identical conditions of temperature and pressure. The rest of these three properties; vapour pressure, boiling point and heat of vaporization will differ as ethanol has hydrogen bonding whereas ether does not.



# CONCEPT MAP

## GENERAL PRINCIPLES AND PROCESSES OF ISOLATION OF ELEMENTS

### Bauxite Mining

The aluminium production process starts with the mining of bauxite, an aluminium rich mineral in the form of aluminium hydroxide. Around 90% of the global bauxite supply is found in tropical areas.



### Alumina Production

Bauxite is crushed, dried and ground in special mills where it is mixed with NaOH solution at high pressure. This process produces a thick paste which is collected in special containers and heated with steam to remove most of the silicon present in bauxite.

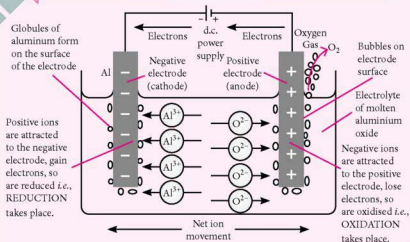


### ALUMINIUM EXTRACTION

The pure form of aluminium does not naturally occur in nature, so remained largely unknown until as recently as 200 years ago. Creating aluminium using electricity was first developed in 1886 and is still used.

### Electrolytic Reduction

At an aluminium smelter, alumina is poured into special reduction cells with molten cryolite at 950°C. Electric current is then induced in the mixture, this current breaks the bonds between aluminium and oxygen atoms resulting in liquid aluminium settling at the bottom of the reduction cell.



### Casting

Primary aluminium is cast into ingots and shipped to customers or used in the production of different alloys.



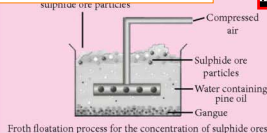
### Alloys Making

Aluminium is shaped in required forms and used for making different products like telephone bodies, aeroplane bodies, etc.



### Recycling

Aluminium is corrosion resistant so it can be remelted and reused an infinite number of times. Recycling aluminium requires only 5% of the energy required to make the same amount of primary aluminium.

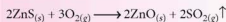


### Concentration of the Ore

The ore is mined, crushed, ball-milled and then concentrated by froth floatation. This removes unwanted components, including the lead compounds and waste rock.

### Roasting of the Ore

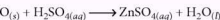
The ore roasting usually takes place in a fluidised bed furnace at around 1300 K, with air being blown in, from the bottom. During roasting  $\text{ZnS}$  is converted to  $\text{ZnO}$ .



The sulphur dioxide is often converted to sulphuric acid in a plant adjacent to the smelter.

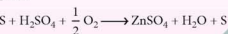
### Conversion of Zinc Oxide to Zinc Sulphate

The crude zinc oxide is leached with spent electrolyte, which is sufficiently acidic in sulphuric acid to dissolve the oxide and restore the concentration of zinc sulphate in the electrolyte solution.



#### Direct Leaching

Several methods have now been developed that dispense with the roasting stage, obtaining zinc sulphate direct from concentrated zinc sulphide ore. They generally use much more extreme conditions, and are suitable for lower-grade ores. One process developed in Canada, and capable of recovering 90% of the zinc from the ore, uses pressures in excess of 10 atmosphere and a temperature of 420 K. The presence of iron in the ore concentrate is important in this method, as it is responsible for the conversion of zinc sulphide to zinc sulphate.

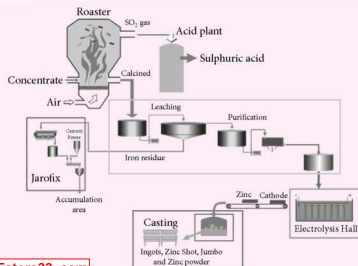


### Electrolysis of Zinc Sulphate Solution

- The last stage entails the purification of zinc by electrolysis of a solution of zinc sulphate.
- Zinc is liberated preferentially at the cathode.
- Every 24 to 72 hours zinc is stripped off the electrodes, melted and cast into ingots. The metal is at least 99.96% pure.

## ZINC EXTRACTION

- Nearly all zinc is obtained from sulphide ores, which also usually contain lead, cadmium and other metals such as iron and silver. The most commonly occurring ores are zinc blende ( $\text{ZnS}$ ), and marmatite which contains significant quantities of iron sulphides.
- The major deposits of sulphide ores are found mainly in North and South America (Canada, US, Mexico, Peru, Bolivia), Australia, Japan and China.





## Class XII

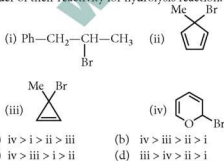
Be **NEET****READY**with exclusive and brain  
storming MCQs

Practicing these MCQs helps to strengthen your concepts and give you extra edge in your NEET preparation

1. Select the incorrect option.
- (a) Packing fraction of an ionic compound which has NaCl type lattice is 80.55%.
- (b) Frenkel defect is also known as dislocation defect.
- (c) The distance between nearest neighbours in CsCl structure is  $\frac{\sqrt{3}a}{2}$  (edge length =  $a$ ).
- (d) The number of nearest neighbours is 6 in fcc lattice.

2. Two oxides of nitrogen, NO and NO<sub>2</sub> react together at 253 K and form a compound of nitrogen, 'x'. 'x' reacts with water to yield another compound of nitrogen, 'y'. The shape of the anion of 'y' molecule is
- (a) tetrahedral (b) angular  
(c) square planar (d) pyramidal.

3. Arrange the following compounds in decreasing order of their reactivity for hydrolysis reaction.



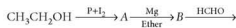
4. The following data were obtained during the first order thermal decomposition of SO<sub>2</sub>Cl<sub>2</sub> at a constant volume:  $\text{SO}_2\text{Cl}_{2(g)} \longrightarrow \text{SO}_{2(g)} + \text{Cl}_{2(g)}$

Exp.	Time (sec)	Total pressure (atm)
1	0	0.5
2	100	0.6

Find out rate of reaction ( $\text{atm sec}^{-1}$ ) when total pressure is 0.65 atm. (Initially only SO<sub>2</sub>Cl<sub>2</sub> is taken)

- (a)  $1.5 \times 10^{-3}$  (b)  $8.06 \times 10^{-4}$   
(c)  $2.3 \times 10^{-3}$  (d)  $4.03 \times 10^{-4}$
5. The correct statement(s) about MnO<sub>4</sub><sup>-</sup> and Cr<sub>2</sub>O<sub>7</sub><sup>2-</sup> is/are
- (a) all the bond lengths are identical in both anions separately
- (b) both the anions are colourless and diamagnetic
- (c) both the anions are coloured and paramagnetic
- (d) both KMnO<sub>4</sub> and K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> on heating produce same colourless paramagnetic gas.

6. In the following sequence of reactions,

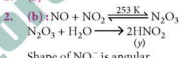


$\text{C} \xrightarrow{\text{H}_2\text{O}} \text{D}$ . The compound 'D' is




- (a) *n*-propyl alcohol (b) propanal  
(c) butanal (d) *n*-butyl alcohol.

- (a)  $\text{CH}_3 - \underset{\text{OCH}_3}{\text{CH}} - \text{COOH}$   
 (b)  $\text{CH}_3 - \text{CH}_2 - \underset{\text{OH}}{\text{CH}} - \text{COOH}$   
 (c)  $\text{CH}_3 - \text{CH}_2 - \underset{\text{CH}_2\text{OH}}{\text{CH}} - \text{COOH}$   
 (d)  $\text{CH}_3 - \underset{\text{OH}}{\text{CH}} - \text{CH}_2 - \text{COOH}$

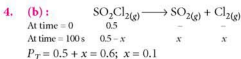
1. (a)



Shape of  $\text{NO}_2^-$  is angular.

3. (c) : Rate of hydrolysis depends upon the stability of carbocation formed.
- (i)  $\text{Ph}-\text{CH}_2-\underset{\text{Br}}{\underset{|}{\text{CH}}}-\text{CH}_3 \xrightarrow{-\text{Br}^-} \text{Ph}-\text{CH}_2-\overset{+}{\text{CH}}-\text{CH}_3$   
 2° carbocation
- (ii)  Antiaromatic carbocation
- (iii)  Aromatic (2π-delocalization)
- (iv)  Aromatic (6π-delocalization)

Hence, the rate of hydrolysis follows the order :  
iv > iii > i > ii





**BRUSH  
UP**

# YOUR CONCEPTS

**Class  
XII**

This specially designed column will help you to brush up your concepts by practicing questions. You can mail us your queries and doubts related to this topic at [editor@mtg.in](mailto:editor@mtg.in). The queries will be entertained by the author.\*

## ELECTROCHEMISTRY

In continuation to the last article :

- **Conductance (G)** : The ease with which current flows through an electrolyte is called conductance. Its unit is  $\text{ohm}^{-1}$  ( $\Omega^{-1}$ ) or mho or Siemens(S).

$$G = \frac{1}{\text{resistance (R) due to solvent}}$$

Remember : Mobility of ions increases with dilution which outweighs the increase in resistance and hence conductance increases with increase in dilution.

- **Conductivity or Specific Conductance ( $\kappa$ )** : It is inverse of specific resistance and is directly proportional to the number of ions in unit volume. Hence, decrease with increase in dilution is observed.

$$R \text{ (resistance)} \propto \frac{l \text{ (distance between electrodes)}}{a \text{ (area of cross section of two parallel plates of electrodes)}}$$

$$R = \rho \left( \frac{l}{a} \right) \Rightarrow \frac{1}{\rho} = \frac{1}{R} \left( \frac{l}{a} \right) \text{ or } \kappa = G G^*$$

$$G^* \left( = \frac{l}{a} \right) \text{ is cell constant of conductivity cell.}$$

Unit of  $\kappa$  is Siemens  $\text{cm}^{-1}$  or Siemens  $\text{m}^{-1}$ .  
Conductivity = conductance  $\times$  cell constant  
Conductivity of a solution of a given concentration is equal to conductance when it is kept between two electrodes of unit area separated by unit length (cm or m in both the cases).

- **Molar Conductivity or Molar Conductance ( $\Lambda_m$ )** : It is the conductance of all the ions produced by 1 mole of electrolyte present in  $V \text{ cm}^3$  (i.e., mL) solution.

$$\Lambda_m = \kappa V \text{ [}\kappa \text{ is in } \text{S cm}^{-1}\text{]}$$

$$\text{If } C \text{ moles are present in } 1000 \text{ cm}^3, V = \frac{1000}{C}$$

$$\Lambda_m = \frac{\kappa \times 1000}{C} \text{ S cm}^2 \text{ mol}^{-1}$$

If  $\kappa$  is in  $\text{S m}^{-1}$ , and  $C$  moles are present in 1 L, i.e.,  $10^{-3} \text{ m}^3$ ,

$$V = \frac{10^{-3}}{C} \text{ m}^3$$

$$\Lambda_m = \kappa \times \frac{1}{1000 C} \text{ S m}^2 \text{ mol}^{-1}$$

It increases with dilution because of higher mobility of ions.

- **Debye-Huckel-Onsager Equation :**

For strong electrolytes,  $\Lambda_m$  increases by small value, on dilution because of high degree of ionisation.

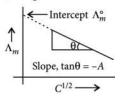
$$\Lambda_m = \Lambda_m^\circ - A C^{1/2}$$

$\Lambda_m^\circ$  is limiting molar conductivity at infinite dilution.

$\Lambda_m$  when plotted against  $\sqrt{C}$ , we get

$-A$  is slope which depends upon the nature of solute and temperature. All 1-1 electrolytes NaCl, KBr, etc, have same value of  $A$ .  $\text{CaCl}_2$ ,  $\text{BaBr}_2$ , etc.

2-1 electrolytes have the same value of  $A$  but different from 1-1 electrolytes, etc.



- **Kohlrausch's Work :**

He found that difference of  $\Lambda_m^\circ$  of electrolytes  $\text{KX}$  and  $\text{NaX}$  for any  $X$  is nearly constant.

$$\begin{aligned} \Lambda_m^\circ(\text{KCl}) - \Lambda_m^\circ(\text{NaCl}) &= \Lambda_m^\circ(\text{KBr}) - \Lambda_m^\circ(\text{NaBr}) \\ &= \Lambda_m^\circ(\text{KI}) - \Lambda_m^\circ(\text{NaI}) = 23.4 \text{ S cm}^2 \text{ mol}^{-1} \end{aligned}$$

\*By R.C. Grover, having 45+ years of experience in teaching chemistry.

Similarly,

$$\Lambda_m^\circ(\text{NaBr}) - \Lambda_m^\circ(\text{NaCl}) = \Lambda_m^\circ(\text{KBr}) - \Lambda_m^\circ(\text{KCl}) \\ \approx 1.8 \text{ S cm}^2 \text{ mol}^{-1}$$

**He enunciated Kohlrausch Law of Independent Migration of Ions :** Limiting molar conductivity of an electrolyte can be represented as the sum of the individual contributions of anions and cations of the electrolyte.

$$\Lambda_m^\circ(X_a Y_b) = a\lambda_{X^+}^\circ + b\lambda_{Y^-}^\circ \\ \text{or } \Lambda_m^\circ = \nu_+ \lambda_{+}^\circ + \nu_- \lambda_{-}^\circ$$

$$\text{Approximate degree of dissociation} = \frac{\Lambda_m}{\Lambda_m^\circ}$$

Acid dissociation constant  $K_a$  or base dissociation constant  $K_b$

$$= \frac{C\alpha^2}{1-\alpha} = \frac{C \left( \frac{\Lambda_m}{\Lambda_m^\circ} \right)^2}{1 - \frac{\Lambda_m}{\Lambda_m^\circ}} = \frac{C\Lambda_m^2}{\Lambda_m^\circ(\Lambda_m^\circ - \Lambda_m)}$$

### Equivalent Conductivity or Equivalent Conductance ( $\Lambda_{eq}$ ) :

It is the conductivity of all the ions produced by one gram-equivalent of an electrolyte in given solution.

$$\Lambda_{eq} = \kappa V$$

$$\text{For normality } N, \Lambda_{eq} = \kappa \times \frac{1000}{N} \text{ ohm}^{-1} \text{ cm}^2 \text{ eq}^{-1}$$

It should be noted that  $M\Lambda_m = N\Lambda_{eq}$

$$(a) \Lambda_m[\text{Al}_2(\text{SO}_4)_3] = 2\lambda_{\text{Al}^{3+}}^\circ + 3\lambda_{\text{SO}_4^{2-}}^\circ$$

$$\Lambda_{eq}[\text{Al}_2(\text{SO}_4)_3] = \frac{1}{3}\lambda_{\text{Al}^{3+}}^\circ + \frac{1}{2}\lambda_{\text{SO}_4^{2-}}^\circ$$

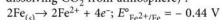
Here,  $\lambda_{\text{Al}^{3+}}^\circ$  and  $\lambda_{\text{SO}_4^{2-}}^\circ$  are molar conductances at infinite dilution.

$$(b) \Lambda_{eq}[\text{Al}_2(\text{SO}_4)_3] = \lambda_{\text{Al}^{3+}}^\circ + \lambda_{\text{SO}_4^{2-}}^\circ$$

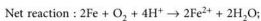
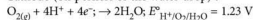
Here,  $\lambda_{\text{Al}^{3+}}^\circ$  and  $\lambda_{\text{SO}_4^{2-}}^\circ$  are equivalent conductances at infinite dilution.

### Corrosion : It is layer by layer destructive oxidation of metals under environmental conditions. Corrosion of iron is called rusting. Chemically rust is hydrated ferric oxide, $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ .

Rusting is a redox reaction having EMF = 1.67 V  
Anode (under water drop that forms  $\text{H}_2\text{CO}_3$  on dissolving  $\text{CO}_2$  from atmosphere) :



Cathode (on periferi of the water drop) :



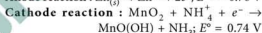
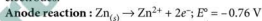
$$E_{\text{cell}}^\circ = 1.67 \text{ V} \\ 2\text{Fe}^{2+} + (2+x)\text{H}_2\text{O} + \frac{1}{2}\text{O}_2 \rightarrow 4\text{H}^+ + \text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$$

### Rusting can be prevented by

- Coating iron objects by oil, grease, paint.
- Coating iron objects by more active metals (Zn-galvanisation). It is sacrificial protection where the coated metal like Zn gets oxidised and Fe is saved.
- Sometimes a less reactive metal which forms protective oxide layer can also be used for coating, e.g., Cr.
- Iron pipes placed in marsh or water are connected to Mg, Zn, Al, etc, through wires which lose electrons easily and protect iron objects. It is called electrical protection.

### Primary cells or Batteries : These are not rechargeable, once consumed, are thrown.

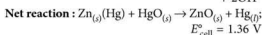
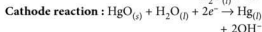
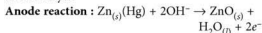
(a) **Dry (Leclanche) cell** : Cathode is graphite rod surrounded by  $\text{MnO}_2 + \text{C} + \text{NH}_4\text{Cl}$  powder placed in Zn container as anode. A paste of  $\text{ZnCl}_2$  and  $\text{NH}_4\text{Cl}$  is used as packing between the two electrodes.



$$\text{Net potential } (E_{\text{cell}}^\circ) = 1.5 \text{ V}$$

$\text{Zn}^{2+}$  forms complex  $[\text{Zn}(\text{NH}_3)_4]^{2+}$ .

(b) **Mercury cell** : It is commonly called as button cell and is used in hearing aids, watches, calculators, etc. Anode is Zn – Hg amalgam, cathode is paste of  $\text{HgO}$  and carbon and paste of  $\text{KOH}$  and  $\text{ZnO}$  as electrolyte.



Since, no ions are involved in the net reaction. The potential of the cell does not fall during its life.

### Secondary cells or Batteries : These batteries or cells can be recharged by passing current in the reverse direction. The most common is lead storage battery used in invertors and automobiles.

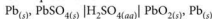
**Lead-storage battery** : Anode has compressed spongy lead plates, cathode has lead plates packed

with  $\text{PbO}_2$ , electrolyte is 3.7 M (approximately 38% by mass)  $\text{H}_2\text{SO}_4$  of specific gravity 1.215.

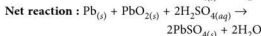
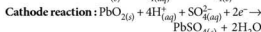
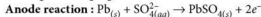
Cell needs recharging when specific gravity falls to about 1.15.

Maximum voltage per cell is 2.15 V which should not fall below 1.7 V, otherwise lead plates will break.

Cell representation :



**During discharging :**

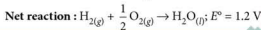
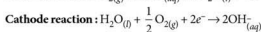
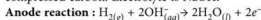


During recharging, these reactions get reversed.

### ○ $\text{H}_2 - \text{O}_2$ Fuel Cell (Bacon Cell) :

This cell has the highest efficiency of about 70% among all known systems of the world.

Anode contains finely divided Pt or Pd while cathode has  $\text{Ag}_2\text{O}$  with Pt or Pd packed in compressed carbon. Electrolyte is NaOH.



### MULTIPLE CHOICE QUESTIONS

- Which of the following has the highest efficiency among all the known systems so far?
  - Human being
  - Steam plant generating electricity
  - Hydrogen - oxygen fuel-cell
  - Lead accumulator
- In the  $\text{H}_2 - \text{O}_2$  fuel cell the anode reaction is
  - $\text{Zn} \rightarrow \text{Zn}^{2+} + 2e^-$
  - $\text{H}_2 + 2\text{OH}^- \rightarrow 2\text{H}_2\text{O} + 2e^-$
  - $\text{H}_2 + \frac{1}{2}\text{O}_2 \rightarrow \text{H}_2\text{O}$
  - $\text{Pb} + \text{SO}_4^{2-} \rightarrow \text{PbSO}_4 + 2e^-$
- If a fuel cell,  $\text{H}_2 + \frac{1}{2}\text{O}_2 \rightarrow \text{H}_2\text{O}$  has  $\Delta G^\circ = -240 \text{ kJ}$ , the  $E^\circ_{\text{cell}}$  is
  - 1 V
  - 1.24 V
  - 2.15 V
  - 1.36 V
- Which of the following is not correct for lead accumulator?
  - Electrolyte is 3.7 M  $\text{H}_2\text{SO}_4$ .
  - EMF per cell is 2.15 V.
  - Anode is Pb plate packed with  $\text{PbO}_2$ .
  - Cell needs recharging when specific gravity of  $\text{H}_2\text{SO}_4$  falls to 1.15.
- Which of the following is the correct cathode reaction in dry cell?
  - $\text{HgO} + \text{H}_2\text{O} + 2e^- \rightarrow \text{Hg} + 2\text{OH}^-$
  - $\text{H}_2\text{O} + \frac{1}{2}\text{O}_2 + 2e^- \rightarrow 2\text{OH}^-$
  - $\text{O}_2 + 4\text{H}^+ + 4e^- \rightarrow 2\text{H}_2\text{O}$
  - $\text{MnO}_2 + \text{NH}_4^+ + e^- \rightarrow \text{MnO}(\text{OH}) + \text{NH}_3$
- What is rust chemically?
  - $\text{Fe}(\text{OH})_3$
  - $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$
  - $\text{Fe}_3\text{O}_4 \cdot x\text{H}_2\text{O}$
  - $\text{FeO} \cdot x\text{H}_2\text{O}$
- Galvanisation is basically a method of preventing rusting under sacrificial protection. The metal coated on iron objects is
  - Cr
  - Sn
  - Mg
  - Zn
- Rusting of iron is basically a redox reaction. The EMF of the cell formed is
  - 1.67 V
  - 1.24 V
  - 2.15 V
  - 1.36 V
- The net reaction of rusting, combination of cathode reaction and anode reaction is
 
$$2\text{Fe} + \text{O}_2 + 4\text{H}^+ \rightarrow 2\text{Fe}^{2+} + 2\text{H}_2\text{O}; E^\circ = 1.67 \text{ V}$$
 Which of the following is oxidised in this reaction?
  - Fe
  - $\text{O}_2$
  - $\text{H}^+$
  - $\text{Fe}^{2+}$
- In dry (Leclanche) cell graphite rod at cathode is surrounded by
  - $\text{ZnCl}_2 + \text{NH}_4\text{Cl}$
  - $\text{ZnCl}_2 + \text{NH}_4\text{Cl} + \text{C}$
  - $\text{MnO}_2 + \text{NH}_4\text{Cl}$
  - $\text{MnO}_2 + \text{NH}_4\text{Cl} + \text{C}$
- Which of the following cell is commonly used in wrist watches?
  - Dry cell
  - Bacon cell
  - Ni-Cd cell
  - Hg-cell
- Which of the following is correct when lead storage battery is discharged (working)?
  - $\text{PbSO}_4$  is formed at anode and  $\text{PbO}_2$  at cathode.
  - $\text{PbSO}_4$  is formed at cathode and  $\text{PbO}_2$  at anode.
  - $\text{PbSO}_4$  is formed at cathode and anode both.
  - $\text{PbO}_2$  is formed at cathode and anode both.
- The values of  $\Delta^\circ_{\text{CH}_3\text{COONa}}$  and  $\Delta^\circ_{\text{HCl}}$  are  $91 \text{ S cm}^2 \text{ mol}^{-1}$  and  $426.2 \text{ S cm}^2 \text{ mol}^{-1}$  respectively. Which of the following will you need for calculating the value of  $\Delta^\circ_{\text{CH}_3\text{COOH}}$ ?

- (a)  $\Lambda_{\text{NaH}}^{\circ}$  (b)  $\Lambda_{\text{CH}_3\text{COCl}}^{\circ}$   
(c)  $\Lambda_{\text{NaCl}}^{\circ}$  (d)  $\Lambda_{\text{NaOH}}^{\circ}$
14. For molar concentration of HA being 0.08 M, the  $\Lambda_m$  value is 75 mho  $\text{cm}^2 \text{mol}^{-1}$ . What is the value of acid dissociation constant  $K_a$  if  $\Lambda_{\text{NaOH}}^{\circ}$  is 300 mho  $\text{cm}^2 \text{mol}^{-1}$  at 25 °C?  
(a) 0.67 (b) 0.067 (c) 0.0067 (d) 0.6077
15. Kohlrausch law can be applied to  
(a) strong electrolytes at high concentration  
(b) weak electrolytes at low concentration  
(c) all electrolytes at moderate dilution  
(d) all electrolytes at infinite dilution.
16. The plot of  $\Lambda_m$  vs  $\sqrt{C}$  of strong electrolyte can be represented by the mathematical equation  $\Lambda_m = \Lambda_m^{\circ} - A\sqrt{C}$ . The equation is commonly regarded as  
(a) Kohlrausch equation  
(b) Debye-Huckel-Onsager equation  
(c) Nernst equation of molar conductivity  
(d) Equation of electrochemical thermodynamics.
17. Which of the following expression correctly represents the equivalent conductance at infinite dilution of  $\text{Al}_2(\text{SO}_4)_3$ ? (Given that  $\Lambda_{\text{Al}^{3+}}^{\circ}$  and  $\Lambda_{\text{SO}_4^{2-}}^{\circ}$  are equivalent conductances at infinite dilution of the respective ions.)  
(a)  $2\Lambda_{\text{Al}^{3+}}^{\circ} + 3\Lambda_{\text{SO}_4^{2-}}^{\circ}$   
(b)  $\Lambda_{\text{Al}^{3+}}^{\circ} + \Lambda_{\text{SO}_4^{2-}}^{\circ}$   
(c)  $(\Lambda_{\text{Al}^{3+}}^{\circ} + \Lambda_{\text{SO}_4^{2-}}^{\circ}) \times 6$   
(d)  $\frac{1}{3}\Lambda_{\text{Al}^{3+}}^{\circ} + \frac{1}{2}\Lambda_{\text{SO}_4^{2-}}^{\circ}$
18. Which of the following is the correct unit of conductivity ( $\kappa$ )?  
(a)  $\text{S cm}^2 \text{mol}^{-1}$  (b)  $\text{S cm}^{-1}$   
(c)  $\text{S}^2 \text{cm}^{-1}$  (d)  $\text{S}^2 \text{cm mol}^{-1}$
19. Which of the following is the correct unit of molar conductivity?  
(a)  $\text{S cm}^2 \text{mol}^{-1}$  (b)  $\text{S cm}^{-1}$   
(c)  $\text{S}^2 \text{cm}^{-1}$  (d)  $\text{S}^2 \text{cm mol}^{-1}$
20. Which of the following has lowest conductivity?  
(a) 1 M NaOH (b) 0.1 M NaOH  
(c) 0.01 M NaOH (d) 0.001 M NaOH
21. Which of the following has lowest molar conductivity?  
(a) 1 M NaOH (b) 0.1 M NaOH  
(c) 0.01 M NaOH (d) 0.001 M NaOH
22. If  $\Lambda_m$  and  $\Lambda_m^{\circ}$  are the molar conductivities of an electrolyte HA (weak acid) then, acid dissociation constant will be  
(a)  $\frac{C \Lambda_m^2}{\Lambda_m (\Lambda_m^{\circ} - \Lambda_m)}$  (b)  $\frac{C \Lambda_m^{\circ}}{\Lambda_m (\Lambda_m^{\circ} - \Lambda_m)}$   
(c)  $\frac{C \Lambda_m^2}{\Lambda_m (\Lambda_m^{\circ} - \Lambda_m)}$  (d)  $\frac{C (\Lambda_m^{\circ} - \Lambda_m)}{\Lambda_m \Lambda_m^{\circ}}$
23. Which of the following is correct with standard symbols being used?  
(a)  $\kappa = GG^*$  (b)  $G = \kappa G^*$   
(c)  $G^* = \kappa G$  (d)  $\kappa = (GG^*)^2$
24. What is the conductance of the solution containing M/10 NaCl solution if its specific conductance is 0.02  $\text{S cm}^{-1}$  and cell constant is 0.6  $\text{cm}^{-1}$ ?  
(a) 0.11 S (b) 0.22 S  
(c) 0.011 S (d) 0.033 S
25. We take 250 mL of 0.5 M KCl and add 250 mL water to it. Which of the following will decrease?  
(a) Conductance  
(b) Specific conductance  
(c) Molar conductance  
(d) Equivalent conductance

## SOLUTIONS

1. (c) :  $\text{H}_2 - \text{O}_2$  fuel cell has approximately 70% efficiency.
2. (b) : Anode for oxidation, i.e., loss of electron. Here  $\text{H}_{2(g)}$  gives  $\text{H}^+$  and  $e^-$ .
3. (b) :  $-nFE^{\circ} = \Delta G^{\circ} \Rightarrow E^{\circ} = \frac{\Delta G^{\circ}}{-nF}$   
 $E^{\circ} = \frac{-240 \times 1000}{-2 \times 96500} = 1.24 \text{ V}$   
[ $n = 2$  for  $\text{H}_2 \rightarrow 2\text{H}^+ + 2e^-$ ]
4. (c) : Anode is simply lead plate.
5. (d) 6. (b) 7. (d) 8. (a)
9. (a) : Fe is oxidised to  $\text{Fe}^{2+}$  by the loss of 2 electrons.
10. (d) 11. (d)
12. (c) : Anode reaction :  $\text{Pb}_{(s)} + \text{SO}_4^{2-}_{(aq)} \rightarrow \text{PbSO}_{4(s)} + 2e^-$   
Cathode reaction :  $\text{PbO}_{2(s)} + 4\text{H}^+_{(aq)} + \text{SO}_4^{2-}_{(aq)} + 2e^- \rightarrow \text{PbSO}_{4(s)} + 2\text{H}_2\text{O}$
13. (c) :  $\Lambda_{\text{CH}_3\text{COOH}}^{\circ} = \Lambda_{\text{CH}_3\text{COONa}}^{\circ} + \Lambda_{\text{HCl}}^{\circ} - \Lambda_{\text{NaCl}}^{\circ}$   
I II III  
I and II are given, III is required.



$$14. (c) : \alpha = \frac{\Lambda_m}{\Lambda_m^\circ} = \frac{75}{300} = \frac{1}{4}$$

$$K_a = \frac{C\alpha^2}{1-\alpha} = \frac{0.08 \times \frac{1}{16}}{1 - \frac{1}{4}} = \frac{\frac{200}{4}}{\frac{3}{4}} = \frac{1}{150} = 0.0067$$

15. (d)    16. (b)    17. (b)

18. (b)    19. (a)

20. (d) : Lower the concentration, lower is the number of ions per unit volume and hence, lower is the conductivity.

21. (a) : Higher the concentration, lower is the mobility of ions and hence, lower is the molar conductivity.

$$22. (c) : \alpha = \frac{\Lambda_m}{\Lambda_m^\circ}$$

$$K_a = \frac{C\alpha^2}{1-\alpha} = \frac{C \left( \frac{\Lambda_m}{\Lambda_m^\circ} \right)^2}{1 - \frac{\Lambda_m}{\Lambda_m^\circ}} = \frac{C\Lambda_m^2}{(\Lambda_m^\circ)^2 \left( \frac{\Lambda_m^\circ - \Lambda_m}{\Lambda_m^\circ} \right)}$$

$$= \frac{C\Lambda_m^2}{\Lambda_m^\circ (\Lambda_m^\circ - \Lambda_m)}$$

$$23. (a) : R = \rho \times \frac{l}{a} \Rightarrow \frac{1}{\rho} = \frac{1}{R} \times \frac{l}{a} \Rightarrow \kappa = GG^*$$

$$24. (d) : \kappa = GG^*, \text{ i.e., conductance } G = \frac{\kappa}{G^*}$$

$$G = \frac{0.02 \text{ S cm}^{-1}}{0.6 \text{ cm}^{-1}} = 0.033 \text{ S}$$

25. (b) : Specific conductance, i.e., conductivity depends upon number of ions per unit volume which will decrease by increasing dilution.



## Scientist of the Month



**Paul Sabatier**

(5 November, 1854 - 14 August, 1941)

### Early Life and Education

Prof Paul Sabatier was a French chemist, born in Carcassonne. Sabatier studied at the École Normale Supérieure, starting in 1874. Three years later, he graduated at the top of his class. In 1880, he was awarded a Doctor of Science degree from the Collège de France. In 1883 Sabatier succeeded Edouard Filhol at the Faculty of Science, and began a long collaboration with Jean-Baptiste Senderens, so close that it was impossible to distinguish the work of either man. They jointly published 34 notes in the Accounts of the Academy of Science, 11 memoirs in the Bulletin of the French Chemical Society and 2 joint memoirs to the Annals of Chemistry and Physics. The methanation reactions of CO<sub>2</sub> were first discovered by Sabatier and Senderens in 1902.

### Contributions

- Sabatier's earliest research concerned the thermochemistry of sulphur

and metallic sulphates, the subject for the thesis leading to his doctorate.

- In Toulouse, he continued his physical and chemical investigations to sulphides, chlorides, chromates and copper compounds.
- He also studied the oxides of nitrogen and nitrosodisulphonic acid and its salts and carried out fundamental research on partition coefficients and absorption spectra.
- Sabatier greatly facilitated the industrial use of hydrogenation.
- The reduction of carbon dioxide using hydrogen at high temperature and pressure is another use of nickel catalyst to produce methane. This is called the Sabatier reaction and is used in the International Space Station to produce the necessary water without relying on stock from the earth.
- Sabatier is best known for the Sabatier process and his works such as La Catalyse en Chimie Organique (Catalysis in organic chemistry) which was published in 1913.

### Honors

- Sabatier was honoured for his work improving the hydrogenation of organic species in the presence of metals.
- Sabatier and Senderens shared the Academy of Science's Jucker Prize in 1905 for their discovery of the Sabatier-Senderens Process.
- He won the Nobel Prize in Chemistry jointly with fellow Frenchman Victor Grignard in 1912.
- The Paul Sabatier University in Toulouse is named in honor of Paul Sabatier.
- Paul Sabatier was a co-founder of the Annales de la Faculté des Sciences de Toulouse, together with the mathematician Thomas Joannes Stieltjes.



# CBSE DRILL



## GENERAL INSTRUCTIONS

- (i) All questions are compulsory.
- (ii) Q. no. 6 to 12 are short answer questions and carry 2 marks each.
- (v) Q. no. 25 to 27 are long answer questions and carry 5 marks each.
- (iii) Q. no. 1 to 5 are very short answer questions and carry 1 mark each.
- (iv) Q. no. 13 to 24 are also short answer questions and carry 3 marks each.
- (vi) Use log tables if necessary, use of calculators is not allowed.

Maximum Marks : 70

## Aldehydes, Ketones and Carboxylic Acids | Organic Compounds Containing Nitrogen

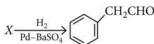
1. What happens when *t*-alkyl amine is oxidised with  $\text{KMnO}_4$ ?
2. Complete the following reaction :  

$$\text{C}_6\text{H}_5\text{CN} \xrightarrow[\text{[H]}]{\text{H}_2/\text{Ni}} ? \xrightarrow{\text{CH}_3\text{I}(\text{excess})} ?$$
3. Account for the following :  
 $\text{Cl}-\text{CH}_2\text{COOH}$  is a stronger acid than  $\text{CH}_3\text{COOH}$ .
4. Which one would you expect to be more reactive towards nucleophilic addition reactions among benzaldehyde and propanal? Explain your answer.

OR

You have been given a mixture of ethanal and ethanol. Suggest a method to separate it into individual component.

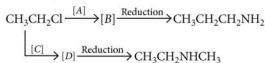
5. Identify  $X$  in the given reaction :



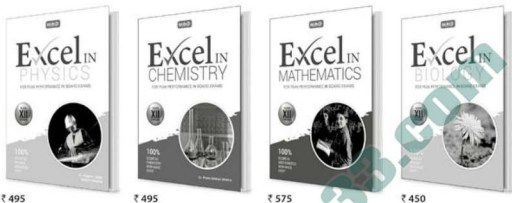
6. (i) Aromatic 1°-amines cannot be prepared by Gabriel phthalimide reaction. Explain.  
(ii) Select the amine which is most reactive towards dil. HCl among the following :  
 $\text{CH}_3\text{NH}_2$ ,  $(\text{CH}_3)_2\text{NH}$ ,  $(\text{CH}_3)_3\text{N}$ ,  $\text{C}_6\text{H}_5\text{NH}_2$

9. How will you convert aniline to 2,4,6-tribromo fluorobenzene.
10. What is *trans*-esterification reaction? Give example.

11. Identify A, B, C and D in the given sequence of reactions,



# Concerned about your performance in **Class XII** Boards?



Well, fear no more, help is at hand.....

To excel, studying in right direction is more important than studying hard. Which is why we created the Excel Series. These books - for Physics, Chemistry, Biology & Mathematics - have been put together totally keeping in mind the prescribed syllabus and the pattern of CBSE's Board examinations, so that students prepare and practice with just the right study material to excel in board exams.

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## HIGHLIGHTS

- Comprehensive theory strictly based on NCERT, complemented with illustrations, activities and solutions of NCERT questions
- Practice questions & Model Test Papers for Board Exams
- Previous years' CBSE Board Examination Papers (Solved)
- CBSE Board Paper 2018 Included



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12. How will you convert ethanal into the following compounds :

- (i) Butane-1, 3-diol
- (ii) But-2-enal?

13. (i) Name the products obtained when an amide containing three carbon atoms is

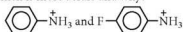
- (a) reduced by  $\text{LiAlH}_4$
- (b) treated with  $\text{Br}_2 + \text{KOH}$ .

(ii) *p*-Methoxyaniline is a stronger base than aniline but *p*-nitroaniline is a weaker base than aniline. Give reason.

14. (i) *t*-Butylamine cannot be prepared by the action of ammonia on *t*-butyl bromide. Why?

(ii) Sulphanilic acid is soluble in dil. NaOH but not in dil. HCl. Explain.

(iii) Which is more acidic and why?



15. Write structural formulae and names of the four possible aldol condensation products of propanal and butanal. In cross aldol, indicate which aldehyde served as nucleophile and which as electrophile.

16. Answer the following questions :

- (i) Hydrazones of aldehydes and ketones are not prepared in highly acidic medium. Explain.
- (ii) What is the function of sodium potassium tartrate (Rochelle's salt) in Fehling's solution?
- (iii) Why does  $\text{HCOOH}$  not give Hell Volhard Zelinsky reaction but  $\text{CH}_3\text{COOH}$  does?

17. (i) How will you convert

- (a) Propionaldehyde to propionic anhydride
- (b) Acetaldehyde to acetoxime

(ii) *tert*-Butylbenzene does not give benzoic acid on oxidation with acidic  $\text{KMnO}_4$ . Explain.

18. Answer the following :

- (i) When a ketone reacts with Grignard reagent a tertiary alcohol is formed but in the reaction of a nitrile with Grignard reagent reaction stops at ketone. Explain why.
- (ii) How does an isocyanide react with an electrophile and a nucleophile at the same isocyanide carbon? Give an example.

19. Give reasons for the following:

- (i) Cyclohexanone forms cyanohydrin in good yield but 2,4,6-trimethylcyclohexanone does not.

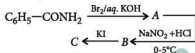
(ii) Aldehydes are more reactive than ketones towards nucleophilic reagents.

(iii) Benzamide is less easily hydrolysed than methyl benzoate.

20. Write the structures of isomeric amines of molecular formula  $\text{C}_7\text{H}_9\text{N}$  and compare their basic strength.

OR

(i) Identify A, B and C.



(ii) Give the decreasing order of reactivity for the following compounds towards coupling with  $\text{PhN}_2\text{Cl}$ .

- I. Aniline
- II. Toluene
- III. Nitrobenzene
- IV. Phenol
- V. Chlorobenzene

21. An organic compound  $\text{C}_7\text{H}_4\text{O}$  gives red precipitate when warmed with Fehling's solution. It also undergoes aldol condensation in presence of NaOH.

(i) Write the IUPAC name of the compound.

(ii) What is the state of hybridisation of carbon atoms in the compound?

(iii) Write the balanced equation for the reactions.

22. (i) Acetone on reaction with HCN gives one compound, whereas acetaldehyde gives two compounds that are difficult to separate. Why?



## COMIC CAPSULE

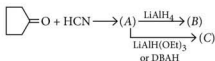
### Why are chemists perfect for solving problems

.....

Because they have all the solutions.



- (ii) Identify A, B, and C in the given sequence of reactions.



23.  $\text{C}_5\text{H}_{13}\text{N} \xrightarrow[\text{Optically active (X)}]{\text{aq. NaNO}_2/\text{HCl}} \text{Y} + \text{Some other products}$   
 $\xrightarrow[\text{Tertiary alcohol}]{-\text{N}_2}$

- (i) Identify (X) and (Y).  
 (ii) Is Y optically active?  
 (iii) Give structures of intermediate(s) if any, in the formation of Y from X.

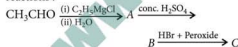
24. Arrange the following compounds in increasing order of the property indicated:

- (i) Acetaldehyde, Acetone, Di-*tert*-butyl ketone, Methyl *tert*-butyl ketone (reactivity towards HCN)  
 (ii) Benzoic acid, 4-Nitrobenzoic acid, 3,4-Dinitrobenzoic acid, 4-Methoxybenzoic acid (acid strength)  
 (iii)  $\text{CH}_3\text{COCl}$ ,  $\text{CH}_3\text{CONH}_2$ ,  $\text{CH}_3\text{COOCH}_3$ ,  $(\text{CH}_3\text{CO})_2\text{O}$  (reactivity in hydrolysis)

25. An organic compound (A) contains 69.77% carbon, 11.63% hydrogen and rest is oxygen. The molecular mass of the compound is 86. It does not reduce Tollens' reagent but forms an addition compound with sodium hydrogen sulphite and gives a positive iodoform test. On vigorous oxidation it gives ethanoic and propanoic acids. Deduce the possible structure of the organic compound (A)

OR

- (i) Identify A, B and C in the following sequence of reactions:



- (ii) Predict the structures of the products formed when benzaldehyde is treated with  
 (a) conc. NaOH  
 (b)  $\text{HNO}_3/\text{H}_2\text{SO}_4$  (at 273–283 K)

26. (a) Give plausible explanation for each of the following:

- (i) There are two  $-\text{NH}_2$  groups in semicarbazide. However only one is involved in the formation of semicarbazones.

- (ii) Ammonolysis of alkyl halides does not give corresponding amine in pure state.

- (iii) Aniline does not undergo Friedel-Crafts reaction.

- (b) What happens when

- (i) aniline is treated with benzaldehyde

- (ii) a mixture of alcohol and ammonia is passed over heated aluminium oxide as catalyst?

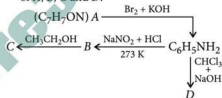
OR

- (i) Account for the following:

- (a) Nitro compounds have higher boiling points than the hydrocarbons having almost the same molecular mass.

- (b) Methylamine solution in water reacts with ferric chloride solution to give a precipitate of ferric hydroxide.

- (ii) An aromatic compound 'A' of molecular formula  $\text{C}_7\text{H}_7\text{ON}$  undergoes a series of reactions as shown below. Write the structures of A, B, C and D.



27. An organic compound (A) (molecular formula,  $\text{C}_8\text{H}_{16}\text{O}_2$ ) was hydrolysed with dilute sulphuric acid to give a carboxylic acid (B) and an alcohol (C). Oxidation of (C) with chromic acid produced (B). (C) on dehydration gives but-1-ene. Write equations for the reactions involved.

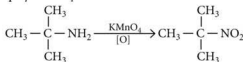
OR

- (i) During the preparation of esters from a carboxylic acid and an alcohol in the presence of an acid catalyst, the water or the ester should be removed as fast as it is formed. Explain why?

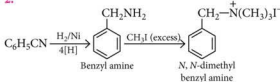
- (ii) Compound 'A' of molecular formula,  $\text{C}_5\text{H}_{11}\text{Br}$ , yields a compound 'B' of molecular formula  $\text{C}_5\text{H}_{12}\text{O}$  when treated with aqueous NaOH. On oxidation, the compound yields a ketone 'C' which gives positive iodoform test. Vigorous oxidation of the ketone yields a mixture of ethanoic and propanoic acids. Deduce the structures of 'A', 'B' and 'C'?

## SOLUTIONS

1. When amine is primary and amino group is attached to a tertiary carbon, it is oxidised to nitro-group by  $\text{KMnO}_4$ .

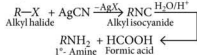


2.

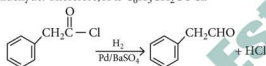


3.  $2\text{CH}_3\text{MgBr} \xrightarrow{\text{CdCl}_2} (\text{CH}_3)_2\text{Cd} + 2\text{Mg} \xrightarrow{\text{Cl}} (\text{CH}_3)_2\text{Cd} + 2\text{C}_6\text{H}_5\text{COCl} \rightarrow 2\text{C}_6\text{H}_5\text{COCH}_3 + \text{CdCl}_2$
- (A) (B)

4. Primary amine and formic acid are formed.



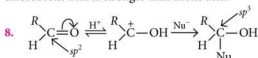
5. The reaction is an example of Rosenmund reduction in which an acid chloride is reduced into an aldehyde. Therefore, X is  $\text{C}_6\text{H}_5\text{CH}_2\text{COCl}$ .



6. (i) Aromatic  $1^\circ$ -amines cannot be prepared by Gabriel phthalimide reaction because aryl halides do not undergo nucleophilic substitution reactions with potassium phthalimide under mild conditions.

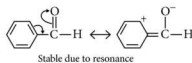
- (ii)  $(\text{CH}_3)_2\text{NH}$  is most basic amongst the given amines. Thus, it is most reactive amine towards HCl.

7. Chloroacetic acid has lower  $\text{pK}_a$  value than acetic acid. 'Cl' in chloroacetic acid shows  $-I$  effect, it creates less electron density on oxygen of carboxylic acid. Thus, release of proton becomes easier than acetic acid. Hence, chloroacetic acid is stronger than acetic acid.



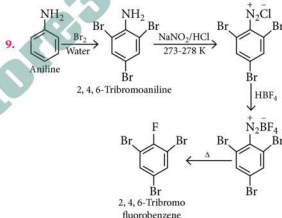
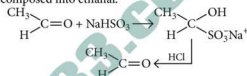
Protonation increases electrophilic nature of the carbonyl carbon for nucleophilic attack.

If R is  $\text{C}_6\text{H}_5$  (that is benzaldehyde), polarity of the carbonyl group is reduced due to resonance. Thus, carbon atom of the carbonyl group present in benzaldehyde is less electrophilic than that of the propanal. Thus, benzaldehyde is less reactive than propanal.

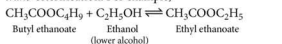


OR

Add sodium bisulphite to the mixture. Ethanal ( $\text{CH}_3\text{CHO}$ ) forms crystalline bisulphite compound and can be separated from ethanol which does not form bisulphite compound. Bisulphite compound can be decomposed into ethanal.



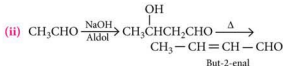
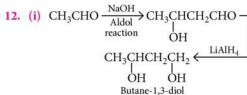
10. Splitting of an ester by an alcohol to form a new ester in which the alkyl group of the higher alcohol is replaced by that of the lower one is termed as *trans*-esterification. For example,



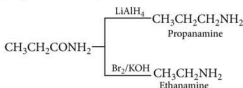
*Trans*-esterification is a reversible reaction. So, generally, this reaction is carried out in the presence of excess alcohol.

11.  $B \xrightarrow{\text{Reduction}} \text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$   
Thus,  $B$  is  $\text{CH}_3\text{CH}_2\text{CN}$  so,  $A$  should be  $\text{KCN}$ .

$D \xrightarrow{\text{Reduction}} \text{CH}_3\text{CH}_2\text{NHCH}_3$   
Thus,  $D$  is  $\text{CH}_3\text{CH}_2\text{NC}$ . Hence,  $C$  is  $\text{AgCN}$ .



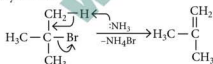
13. (i) The amide containing three carbon atoms is propanamide ( $\text{CH}_3\text{CH}_2\text{CONH}_2$ ). The reactions are



(ii) Methoxy ( $-\text{OCH}_3$ ) group is electron-releasing group due to  $+R$  effect. Therefore, it increases the electron density on the N-atom of the  $-\text{NH}_2$  groups. This makes  $p$ -methoxyaniline a stronger base than aniline.

On the other hand, nitro group ( $-\text{NO}_2$ ) is electron-withdrawing group. This reduces the electron density on the N-atom. As a result,  $p$ -nitroaniline is a weaker base than aniline.

14. (i)  $t$ -Butyl bromide is a  $3^\circ$  alkyl halide. Therefore, it prefers to undergo elimination reaction rather than substitution reaction when treated with  $\text{NH}_3$  (a base). Therefore, the product is isobutylene instead of  $tert$ -butylamine.



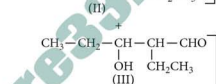
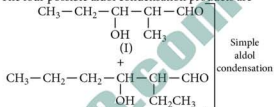
(ii) Sulphanilic acid exists as Zwitter ion,  $\text{H}_3\text{N}^+-\text{C}_6\text{H}_4-\text{SO}_3^-$ . In the presence of dil.  $\text{NaOH}$ , the weakly acidic group transfers its proton to  $\text{OH}^-$  to form soluble  $p$ - $\text{NH}_2\text{C}_6\text{H}_4\text{SO}_3^-\text{Na}^+$ . On the other hand,  $-\text{SO}_3^-$  group is a very weak base and therefore, it does not

accept  $\text{H}^+$  ion from dil.  $\text{HCl}$  to form  $p$ - $\text{NH}_3^+\text{C}_6\text{H}_4\text{SO}_3\text{H}$  and hence, it does not dissolve in dil.  $\text{HCl}$ .

(iii) Due to its powerful  $-I$  effect, the F-atom withdraws electrons from  $-\text{NH}_2$  group. As a result, electron density on  $\text{NH}_3$  of  $p$ -fluoroanilinium ion decreases and hence, release of proton from  $p$ -fluoroanilinium ion is much easier than from the anilinium ion. Therefore,  $p$ -fluoroanilinium ion is more acidic than anilinium ion.

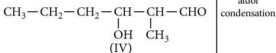


The four possible aldol condensation products are



Nucleophile:  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$

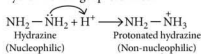
Electrophile:  $\text{CH}_3\text{CH}_2\text{CHO}$



Nucleophile:  $\text{CH}_3\text{CH}_2\text{CHO}$

Electrophile:  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$

16. (i) In highly acidic medium, the  $-\text{NH}_2$  group of hydrazine will get protonated.



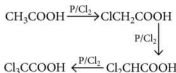
Due to strong  $-I$  effect of the  $\text{NH}_3^+$  group in protonated hydrazine, the lone pair of electron on  $-\text{NH}_2$  group is not available for nucleophilic attack on the carbonyl ( $>\text{C}=\text{O}$ ) group and therefore, hydrazone formation does not occur.

(ii) Fehling's solution is a mixture of alkaline solution of copper sulphate and sodium potassium tartrate solution.

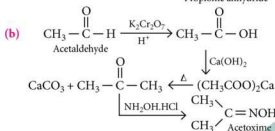
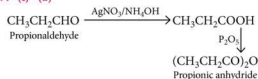


Sodium potassium tartrate forms a soluble complex with insoluble copper hydroxide which is produced from reaction of  $\text{CuSO}_4$  solution with alkali. The soluble complex helps in making reduction of cupric ion to cuprous state a smooth process.

(iii) Acetic acid ( $\text{CH}_3\text{COOH}$ ) has  $\alpha$ -hydrogens, hence it undergoes HVZ reaction but  $\text{HCOOH}$  acid has no  $\alpha$ -hydrogen, therefore, it does not give HVZ reaction.



17. (i) (a)

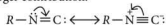


(ii) Alkyl benzenes such as toluene, ethylbenzene, *n*-propylbenzene and isopropylbenzene which contain one or more benzylic hydrogens undergo oxidation to form benzoic acid.

But, *tert*-butylbenzene ( $3^\circ$  alkyl chain) has no benzylic hydrogen and therefore, it does not undergo oxidation with acidic  $\text{KMnO}_4$  to give benzoic acid.

18. (i) The reaction of a nitrile with Grignard reagent gives a ketone whereas a ketone reacts with Grignard reagent to form a tertiary alcohol. This is because nitrile is more reactive to the nucleophilic attack by the carbanion of the Grignard reagent than a ketone. Therefore in the presence of a nitrile, the ketone formed does not react with the Grignard reagent and the product is a ketone.

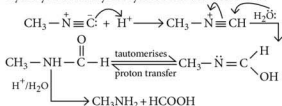
(ii) Isocyanides can be represented as a resonance hybrid of the two canonical forms. The dipolar form makes a larger contribution.



Thus, in an isocyanide molecule, the N atom has a positive and the C atom a negative charge. In its

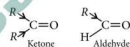
reactions, first an electrophile and then a nucleophile add at the C atom to form a species which transforms into the product(s).

Hydrolysis of methyl isocyanide is illustrated below:



19. (i) The formation of cyanohydrin involves the nucleophilic attack by  $\text{CN}^-$  ion on the carbonyl carbon. The presence of three methyl groups in trimethylcyclohexanone lowers the positive charge on the carbonyl carbon, leading to the decreased nucleophilic attack.

(ii) Ketones are less reactive than aldehydes towards nucleophilic addition reactions because the two electron releasing alkyl groups increase the electron density on the carbonyl carbon and make it less susceptible to nucleophilic attack.



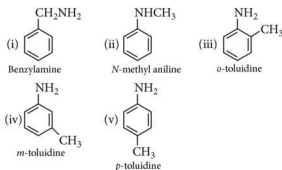
Also, the two bulkier alkyl groups hinder the approach of the nucleophile to the carbonyl carbon.

(iii) Benzamide,  $\text{C}_6\text{H}_5-\overset{\text{O}}{\parallel}{\text{C}}-\text{NH}_2$  and methyl benzoate,  $\text{C}_6\text{H}_5-\overset{\text{O}}{\parallel}{\text{C}}-\text{OCH}_3$  can be represented by a general formula.



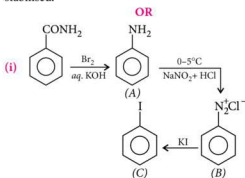
The ease of nucleophilic attack (as by  $\text{H}_2\text{O}$  during hydrolysis) on the carbonyl carbon depends upon the electronegativity of the group G. The  $-\text{OCH}_3$  group is more electronegative than the  $-\text{NH}_2$  group. So, the nucleophilic attack on the carbonyl carbon becomes more favourable in methyl benzoate than in benzamide. As a result, methyl benzoate undergoes hydrolysis more easily than benzamide.

20. Molecular formula suggests that compound is highly unsaturated, hence it has atleast one benzene ring. Thus, isomers are



Basic nature : (iii) < (iv) < (ii) < (v) < (i)

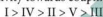
In p-toluidine (v) hyperconjugation and inductive both effects increase basic strength. In (iii) only inductive effect is applied. Benzyl carbocation is resonance stabilised.



(ii) The more electron donating group present in coupling compound, the faster will be coupling. As electron donating power is in the order :



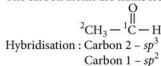
So, order of reactivity towards coupling reaction :



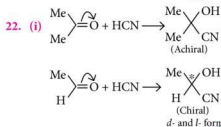
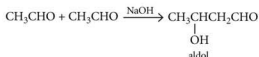
21. The compound gives a positive test with Fehling's solution. So, it is an aldehyde. Since, the compound undergoes aldol condensation, hence it must contain  $\alpha$ -hydrogen atoms. Based upon these, the possible structure of the given compound is  $\text{CH}_3\text{CHO}$ .

(i) Ethanal

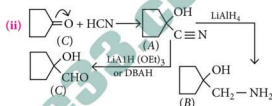
(ii) The carbon atoms are numbered as :



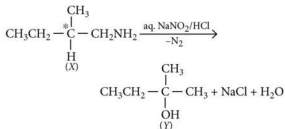
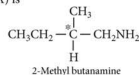
(iii)  $\text{CH}_3\text{CHO} + 2\text{Cu}(\text{OH})_2 + \text{NaOH} \longrightarrow \text{CH}_3\text{COONa} + \text{Cu}_2\text{O} \downarrow + 3\text{H}_2\text{O}$   
Fehling's solution red ppt.



Acetaldehyde gives enantiomers (optical isomers) due to the chiral centre. They are difficult to separate since the chemical and physical properties of enantiomers are same.

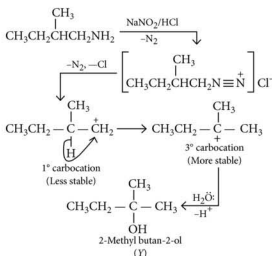


23. (i) Since the compound (X) on treatment with  $\text{HNO}_2$  ( $\text{NaNO}_2/\text{HCl}$ ) evolves  $\text{N}_2$  gas, therefore, (X) must be a primary amine. Further, the compound (X) is optically active, it must contain a chiral carbon. The  $-\text{NH}_2$  group cannot be directly attached to chiral carbon since such amines undergo racemisation due to nitrogen inversion. Therefore, the structure of the compound (X) is



(ii) No, (Y) is not optically active.

(iii) The formation of the compound (Y) from the compound (X) may be explained as follows:



24. (i) Di-*tert*-butyl ketone < Methyl *tert*-butyl ketone < Acetone < Acetaldehyde

(ii) 4-Methoxybenzoic acid < Benzoic acid < 4-Nitrobenzoic acid < 3,4-Dinitrobenzoic acid

(iii)  $\text{CH}_3\text{CONH}_2 < \text{CH}_3\text{COOCH}_3 < (\text{CH}_3\text{CO})_2\text{O} < \text{CH}_3\text{COCl}$

25. Calculation of the empirical formula of the compound :

Element	Percentage	Atomic mass	Relative numbers of atoms	Simple molar ratio
C	69.77	12	$\frac{69.77}{12} = 5.814$	5
H	11.63	1	$\frac{11.63}{1} = 11.63$	10
O	18.6	16	$\frac{18.6}{16} = 1.163$	1

So, the empirical formula is  $\text{C}_5\text{H}_{10}\text{O}$ .

Empirical formula mass =  $(5 \times 12) + (10 \times 1) + (1 \times 16) = 86$

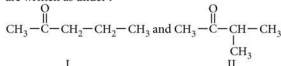
Given that molecular mass of the compound = 86

Hence, the molecular formula and empirical formula are same as,  $\text{C}_5\text{H}_{10}\text{O}$ .

The given compound does not reduce Tollens' reagent, so it is not an aldehyde but the formation of addition compound with sodium hydrogen sulphite indicates it is a carbonyl compound. Since, this compound gives

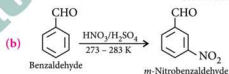
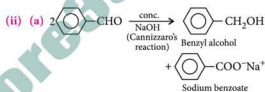
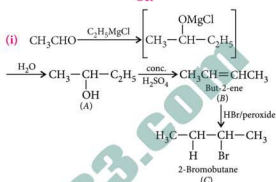
positive iodoform test, so it should contain  $-\text{C}(=\text{O})-\text{CH}_3$  group.

On the basis of this information, two possible structures are written as under :

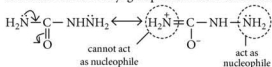


On oxidation, this compound gives ethanoic and propanoic acids which confirm its structure to be I.

OR

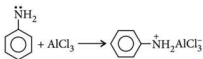


26. (a) (i) The  $-\text{NH}_2$  group next to  $>\text{C}=\text{O}$  group becomes unreactive due to the shifting of double bond and lone pair thus cannot act as a nucleophile while the  $-\text{NH}_2$  group attached to  $\text{NH}-$  can act as a nucleophile and react with carbonyl group to form semicarbazone.

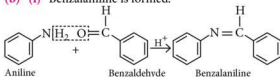


(ii) During ammonolysis of alkyl halides, pure amine cannot be prepared because as soon as primary amine is formed it may further react with alkyl halide to give secondary amine which on further reaction with alkyl halide gives *tert*-amine which may finally form quaternary ammonium salt. Thus a mixture of 1°, 2°, 3° amine and 4° ammonium salt is formed.

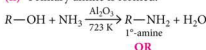
(iii) In Friedel — Crafts reaction,  $\text{AlCl}_3$  is added as a catalyst which is a Lewis acid. It forms a salt with aniline due to which the nitrogen of aniline acquires positive charge. This positively charged nitrogen acts as a strong deactivating group, hence aniline does not undergo Friedel — Crafts reaction.



(b) (i) Benzalaniline is formed.

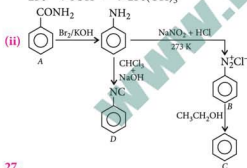
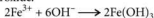
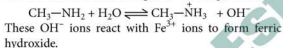


(ii) Primary amine is formed.

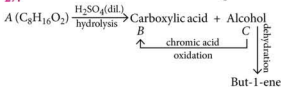


(i) (a) The nitro compounds are highly polar molecules. Due to this polarity they have strong intermolecular dipole - dipole interactions which causes them to have higher boiling points in comparison to the hydrocarbons having almost same molecular mass.

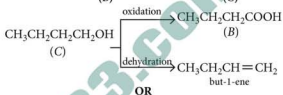
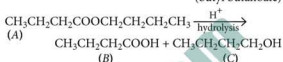
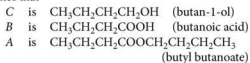
(b) Methylamine forms hydroxide ions when dissolved in water due to the following acid - base equilibrium.



27.

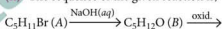


From the reactions given we can conclude that, A is an ester, B is a carboxylic acid and C is a primary alcohol. Since a primary alcohol on oxidation gives a carboxylic acid with the same number of carbon atoms, each of these contains 4 carbon atoms. C gives but-1-ene on dehydration. This indicates that

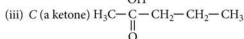
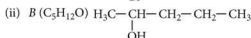
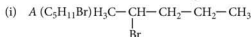


(i) The reaction between an acid and an alcohol in the presence of an acid catalyst is a reversible reaction. To let the reaction proceed in the forward direction (so as to have the maximum yield), one of the products formed, i.e., the ester or water, should be removed as fast as it is formed.

(ii) The sequence of the given reaction is,



Since, the final products contain 2 and 3 carbon atoms respectively and C gives positive iodoform test hence carbonyl group of the 'ketone' (C) should occur at carbon atom number 2 in the chain of five carbon atoms. Ketones are obtained from the oxidation of secondary alcohols. So, 'B' should be a secondary alcohol, with  $-OH$  group at carbon atoms 2. Since,  $-OH$  has replaced Br in the molecule, hence the 'Br' should be attached to carbon atom number 2 in the compound 'A'. The structural formulae of A, B and C are given below:



Class XII

# MONTHLY TUNE UP!



## PRACTICE PROBLEMS

These practice problems enable you to self analyse your extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Performance analysis table given at the end will help you to check your readiness.

- The *d*- & *f*- Block Elements
- Coordination Compounds

Total Marks : 120

NEET / AIIMS

Only One Option Correct Type

Time Taken : 60 Min.

- Among *d*-block elements, the most abundant element belongs to the
  - first transition series
  - second transition series
  - third transition series
  - fourth transition series.
- Which complex compound is formed when excess of KCN is added to an aqueous solution of copper sulphate?
  - $\text{Cu}(\text{CN})_2$
  - $\text{K}_2[\text{Cu}(\text{CN})_4]$
  - $\text{K}[\text{Cu}(\text{CN})_2]$
  - $\text{K}_3[\text{Cu}(\text{CN})_4]$
- Acidified solution of chromic acid on treatment with hydrogen peroxide yields
  - $\text{CrO}_3 + \text{H}_2\text{O} + \text{O}_2$
  - $\text{CrO}_5 + \text{H}_2\text{O}$
  - $\text{Cr}_2\text{O}_3 + \text{H}_2\text{O} + \text{O}_2$
  - $\text{H}_2\text{Cr}_2\text{O}_7 + \text{H}_2\text{O} + \text{O}_2$
- Calomel ( $\text{Hg}_2\text{Cl}_2$ ) on reaction with  $\text{NH}_4\text{OH}$  gives
  - $\text{HgNH}_2\text{Cl} + \text{Hg}$
  - $\text{NH}_2 - \text{Hg} - \text{Hg} - \text{Cl}$
  - $\text{Hg}_2\text{O}$
  - $\text{HgO}$
- Which of the following complex is most stable?
  - $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$
  - $[\text{Fe}(\text{CN})_6]^{3-}$
  - $[\text{Fe}(\text{C}_2\text{O}_4)_3]^{3-}$
  - $[\text{FeCl}_6]^{3-}$
- The hypothetical complex chlorodiaquatrimminecobalt(III) chloride can be represented as
  - $[\text{CoCl}(\text{NH}_3)_3(\text{H}_2\text{O})_2]\text{Cl}_2$
  - $[\text{Co}(\text{NH}_3)_3(\text{H}_2\text{O})_2]\text{Cl}$
  - $[\text{Co}(\text{NH}_3)_3(\text{H}_2\text{O})_2]\text{Cl}_2$
  - $[\text{Co}(\text{NH}_3)_3(\text{H}_2\text{O})_3]\text{Cl}_3$
- Which of the following factors may be regarded as the main cause of lanthanide contraction?
  - Poor shielding of *4f*-electrons in compare to other electrons in the sub-shell.
  - Effective shielding of one of the *4f*-electrons by another in the sub-shell.
  - Poor shielding of *5d*-electrons by *4f*-electrons.
  - Greater shielding of *5d*-electrons by *4f*-electrons.
- In which of the following pairs both the ions are coloured in aqueous solution?
  - $\text{Sc}^{3+}$ ,  $\text{Co}^{2+}$
  - $\text{Ni}^{2+}$ ,  $\text{Cu}^+$
  - $\text{Ni}^{2+}$ ,  $\text{Tl}^{3+}$
  - $\text{Sc}^{3+}$ ,  $\text{Tl}^{3+}$
- Which of the following compounds show optical isomerism?
  - cis*- $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$
  - trans*- $[\text{Co}(\text{en})_2\text{Cl}_2]^+$
  - cis*- $[\text{Co}(\text{en})_2\text{Cl}_2]^+$
  - $[\text{Co}(\text{en})_3]^{3+}$
  - (i) and (ii)
  - (ii) and (iii)
  - (iii) and (iv)
  - (i), (iii) and (iv)
- The value of the 'spin only' magnetic moment for one of the following configurations is 2.84 B.M. The correct one is
  - $d^1$  (in strong ligand field)
  - $d^4$  (in weak ligand field)
  - $d^3$  (in weak as well as in strong field)
  - $d^2$  (in strong ligand field).

11. The correct order of decreasing second ionisation enthalpy of Ti(22), V(23), Cr(24) and Mn(25) is  
 (a)  $Mn > Cr > Ti > V$  (b)  $Ti > V > Cr > Mn$   
 (c)  $Cr > Mn > V > Ti$  (d)  $V > Mn > Cr > Ti$
12. *Tris* (ethylenediamine) cobalt (III) cation,  $[Co(en)_3]^{3+}$  can have  
 (a) three stereoisomers, all chiral and optically active  
 (b) two chiral stereoisomers (enantiomers)  
 (c) three stereoisomers, all achiral  
 (d) two stereoisomers, both achiral.

### Assertion & Reason Type

**Directions :** In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

- (a) If both assertion and reason are true and reason is the correct explanation of assertion.  
 (b) If both assertion and reason are true but reason is not the correct explanation of assertion.  
 (c) If assertion is true but reason is false.  
 (d) If both assertion and reason are false.

13. **Assertion :**  $KMnO_4$  is oxidising agent in neutral, acidic and basic medium.

**Reason :** Equivalent mass of  $KMnO_4$  in acidic medium is 31.6

14. **Assertion :** The oxidation state of Pt in Zeise's salt is +2.  
**Reason :** Zeise's salt is non-ionic complex.

15. **Assertion :**  $NF_3$  is weaker ligand than  $N(CH_3)_3$ .  
**Reason :**  $NF_3$  ionizes to give  $F^-$  ions in aqueous solution.

### JEE MAIN / ADVANCED

#### Only One Option Correct Type

16. A metal  $M$  which is not affected by strong acids like conc.  $HNO_3$ , conc.  $H_2SO_4$  and concentrated solutions of alkalis like  $KOH$  and  $NaOH$  but dissolves in aqua regia and forms  $MCl_3$  which is used for toning in photography. The metal  $M$  is  
 (a) Ag (b) Hg (c) Au (d) Cu
17.  $AgCl$  dissolves in a solution of  $NH_3$  but not in water because  
 (a)  $NH_3$  is a better solvent than  $H_2O$   
 (b)  $Ag^+$  forms a complex ion with  $NH_3$   
 (c)  $NH_3$  is a stronger base than  $H_2O$   
 (d) the dipole moment of water is higher than  $NH_3$ .
18. Increasing order of  $\Delta_o$  of the following complex is  
 (a)  $[Cr(NH_3)_6]^{3+} < [Cr(H_2O)_6]^{3+} < [Cr(NO_2)_6]^{3-}$   
 (b)  $[Cr(H_2O)_6]^{3+} > [Cr(NH_3)_6]^{3+} > [Cr(NO_2)_6]^{3-}$   
 (c)  $[Cr(H_2O)_6]^{3+} < [Cr(NH_3)_6]^{3+} < [Cr(NO_2)_6]^{3-}$   
 (d)  $[Cr(NH_3)_6]^{3+} < [Cr(NO_2)_6]^{3-} < [Cr(H_2O)_6]^{3+}$
19. 0.001 mol of  $[Co(NH_3)_5(NO_3)(SO_4)]$  was passed through a cation exchanger and the acid coming out of it required 20 mL of 0.1 M NaOH for neutralisation. Hence, the complex is  
 (a)  $[Co(NH_3)_5SO_4]NO_3$   
 (b)  $[Co(NH_3)_5NO_3]SO_4$   
 (c)  $[Co(NH_3)_5]NO_3 \cdot SO_4$   
 (d) none of these.

### More than One Options Correct Type

20. Reduction of the metal centre in aqueous permanganate ion involves  
 (a) 3 electrons in neutral medium  
 (b) 5 electrons in neutral medium  
 (c) 3 electrons in alkaline medium  
 (d) 5 electrons in acidic medium.
21. The pair(s) of coordination complexes/ions exhibiting the same kind of isomerism is (are)  
 (a)  $[Cr(NH_3)_4Cl]Cl_2$  and  $[Cr(NH_3)_3Cl_2]Cl$   
 (b)  $[Co(NH_3)_4Cl_2]^+$  and  $[Pt(NH_3)_2(H_2O)Cl]^+$   
 (c)  $[CoBr_2Cl_2]^{2-}$  and  $[PtBr_2Cl_2]^{2-}$   
 (d)  $[Pt(NH_3)_3(NO_3)]Cl$  and  $[Pt(NH_3)_3Cl]Br$
22. In which of the following cases, the complex ion formed will migrate towards the anode under the electric field?  
 (a) Excess of aqueous KCN added to  $CdSO_4$   
 (b) Aqueous solution of  $CuSO_4$  containing excess of  $NH_3$   
 (c)  $AgBr$  added to hypo solution in excess  
 (d) A solution of  $AgNO_3$  in aqueous KCN
23. Which of the following statements are correct with reference to  $Fe^{3+}$  ions?  
 (a)  $Fe^{3+}$  gives brown colour with ammonium thiocyanate.  
 (b)  $Fe^{3+}$  gives brown colour with potassium ferrocyanide.  
 (c)  $Fe^{3+}$  gives blue colour with potassium ferrocyanide.  
 (d)  $Fe^{3+}$  gives brown colour with ammonium hydroxide.

### Numerical Value Type

24. Empirical formula of a complex is  $H_{12}O_6Cl_3Cr$ . When it reacts with conc.  $H_2SO_4$ , it loses 13.5% of its original mass. Find out the number of water molecules in coordination sphere of that complex. (atomic weight of Cr = 52, H = 1, Cl = 35.5, O = 16)

25. How many of these have magnetic moment value  $2\sqrt{12}$   
 $Mn^{2+}$ ,  $Mn^{+}$ ,  $Re^{2+}$ ,  $Re^{+}$ ,  $Cr$ ,  $W$
26. Number of diamagnetic species among the following  
 $[Pt(CN)_4]^{2-}$ ,  $[Ni(CO)_4]$ ,  $[NiCl_4]^{2-}$ ,  $[Ni(CN)_4]^{2-}$ ,  
 $[Zn(NH_3)_4]^{2+}$ ,  $[CuCl_4]^{2-}$ ,  $[CoF_6]^{3-}$ ,  $[Co(NH_3)_6]^{3+}$ ,  
 $[Fe(CN)_6]^{4-}$ ,  $[Fe(CN)_6]^{3-}$ ,  $[MnCl_6]^{4-}$  is

### Comprehension Type

An ore (A) on roasting with  $Na_2CO_3$  in the presence of air gives two compounds (B) and (C). The solution of (B) in conc. HCl on treatment with  $K_4[Fe(CN)_6]$  gives blue ppt. of compound (D). The aqueous solution of (C) on treatment with conc.  $H_2SO_4$  gives a yellow coloured compound (E). Compound (E) when treated with KCl gives an orange red compound (F) which is used as an oxidising agent.

27. The compound (D) is  
 (a)  $Fe_4[Fe(CN)_6]_3$  (b)  $KFe[Fe(CN)_6]$   
 (c)  $Fe[Fe(CN)_6]$  (d) both (a) and (b).
28. Orange red compound (F) is produced on addition of KCl to E, because  
 (a) F is more soluble than E  
 (b) F is less soluble than E  
 (c) F is orange red substance  
 (d) E is an yellow coloured substance.

### Matrix Match Type



29. Match the compounds given in Column I with their characteristic test(s)/ reaction(s) given in Column II and mark the appropriate choice.

#### Column-I

(A)  $H_2N-NHC_6H_5$

#### Column-II

(p) Sodium fusion extract of the compound gives prussian blue colour with  $FeSO_4$ .

- (B)  (q) Gives positive  $FeCl_3$  test.
- (C)  (r) Gives white precipitate with  $HNO_3$ .
- (D)  $[Ag(NH_3)_2]Cl$  (s) Reacts with aldehydes to form the corresponding hydrazone derivatives.

#### Codes :

A	B	C	D
(a) s	r	q	p
(b) q	r	p	s
(c) s	q	p	r
(d) p	r	s	q

30. Match column I with column II and choose the correct answer using the codes given below

#### Column I (Complex)

- (A)  $[Cu(CN)_4]^{3-}$   
 (B)  $[Cu(CN)_6]^{4-}$   
 (C)  $[Cu(NH_3)_4]^{2+}$   
 (D)  $[Fe(CN)_6]^{4-}$

#### Column II (Structure and magnetic moment)

- (p) Square planar and 1.73 B.M.  
 (q) Octahedral and zero  
 (r) Tetrahedral and zero  
 (s) Octahedral and 1.73 B.M.

#### Codes :

A	B	C	D
(a) s	q	p	r
(b) p	s	q	r
(c) r	s	q	p
(d) r	s	p	q



Keys are published in this issue. Search now!

## CHECK YOUR PERFORMANCE

No. of questions attempted .....  
 No. of questions correct .....  
 Marks scored in percentage .....

If your score is

> 80%  
 60-80%  
 < 60%

Your preparation is going good, keep it up to get high score.  
 Need more practice, try hard to score more next time.  
 Stress more on concepts and revise thoroughly.



# CHEMISTRY Musing

**PROBLEM SET 64**

**C**hemistry Musing was started from August '13 issue of Chemistry Today. The aim of Chemistry Musing is to augment the chances of bright students preparing for JEE (Main and Advanced) / NEET / AIMS / JIPMER with additional study material. In every issue of Chemistry Today, 10 challenging problems are proposed in various topics of JEE (Main and Advanced) / NEET. The detailed solutions of these problems will be published in next issue of Chemistry Today.


The readers who have solved five or more problems may send their solutions. The names of those who send atleast five correct solutions will be published in the next issue. We hope that our readers will enrich their problem solving skills through "Chemistry Musing" and stand in better stead while facing the competitive exams.

## JEE MAIN/NEET

- From the following information,  
 $X + H_2SO_4 \longrightarrow Y$  (a colourless and irritating gas)  
 $Y + K_2Cr_2O_7 + H_2SO_4 \longrightarrow$  green coloured solution  
 Identify X and Y.  
 (a)  $Cl^-$ ,  $HCl$  (b)  $SO_3^{2-}$ ,  $SO_2$   
 (c)  $S^{2-}$ ,  $H_2S$  (d)  $CO_3^{2-}$ ,  $CO_2$


- Specific heat of certain elementary gas at constant volume is  $315 \text{ J kg}^{-1} \text{ K}^{-1}$  and that at constant pressure is  $441 \text{ J kg}^{-1} \text{ K}^{-1}$ . 7.0 g of the gas is found to occupy a volume of 4.1 L at  $27^\circ\text{C}$  and 1 atm pressure. What is the atomic mass of the gas?  
 (a) 21 u (b) 42 u (c) 63 u (d) 10.5 u


- Choose the correct option among the following statements.


(a)  I will react more readily than


 I for  $S_N1$  reaction.

(b)  Cl will react more readily than

 Br for  $S_N2$  reaction.

(c)  Br will react more readily than

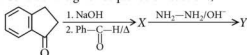
 Br for  $S_N1$  reaction.

(d)   $CH_2Br$  will react more readily than

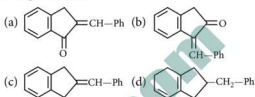
  $CH-Br$  for  $S_N1$  reaction.

- One mole each of  $CaC_2$ ,  $Al_4C_3$  and  $Mg_2C_3$  reacts with  $H_2O$  in separate open flasks at  $25^\circ\text{C}$ . Numerical value of the work done by the system is in the order  
 (a)  $CaC_2 < Al_4C_3 < Mg_2C_3$   
 (b)  $CaC_2 = Mg_2C_3 < Al_4C_3$   
 (c)  $CaC_2 = Mg_2C_3 = Al_4C_3$   
 (d)  $CaC_2 < Al_4C_3 = Mg_2C_3$

- Consider the given sequence of reactions,



Compound (Y) is



For the  
**SCIENTIST** in  
**YOU**

Recently it is shown that nano-filters made of aluminium oxide could be cheaply produced using virtually no energy from a fixed amount of liquid metal gallium. In a paper published, it was explained that when a chunk of aluminium is added to the core of liquid gallium at room temperature, layers of aluminium oxide are quickly produced at the surface of the gallium.

The authors discovered that these aluminium oxide nano-sheets were highly porous and went on to prove they were suitable for filtering both heavy metal ions and oil contamination at unprecedented, ultra-fast rates.

The Professor said that low cost and portable filters produced by this new liquid metal based manufacturing process could be used by people without access to clean drinking water to remove substances like lead and other toxic metals in a matter of minutes.

"Lead and other heavy metals have a very high affinity to aluminium oxide. As the water passes through billions of layers, each one of these lead ions get attracted to one of these aluminium oxide sheets."

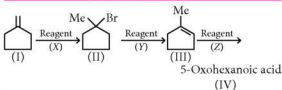
"But at the same time, it's very safe because with repeated use, the water flow cannot detach the heavy metal ions from the aluminium oxide."

"If you've got bad quality water, you just take a gadget with one of these filters with you, pour the contaminated water in the top of a flask with the aluminium oxide filter. Wait two minutes and the water that passes through the filter is now very clean water, completely drinkable."

## JEE ADVANCED

6. Metal *A* reduces silica converting itself into *B*. *B* absorbs moisture and converts into *C*. When aqueous solution of *C* is heated with the reduction product of silica, it liberates a gas *D*. Then *A*, *B*, *C* and *D* are
- $\text{Na}$ ,  $\text{Na}_2\text{O}$ ,  $\text{NaOH}$ ,  $\text{H}_2$
  - $\text{Na}$ ,  $\text{Na}_2\text{O}_2$ ,  $\text{Na}_2\text{CO}_3$ ,  $\text{O}_2$
  - $\text{Mg}$ ,  $\text{MgO}$ ,  $\text{MgCO}_3$ ,  $\text{CO}_2$
  - $\text{Mg}$ ,  $\text{MgO}_2$ ,  $\text{Mg(OH)}_2$ ,  $\text{H}_2$

## COMPREHENSION



7. Reagents (X) and (Y) are

X	Y
(a) $\text{HBr}/\text{RCOOR}$	alc. KOH
(b) $\text{MeBr}$	alc. KOH
(c) $\text{HBr}/h\nu$	aq. KOH
(d) $\text{HBr}$	alc. KOH

8. Reagent (Z) is
- $\text{O}_3/\text{Ph}_3\text{P}$
  - $\text{O}_3/\text{NaBH}_4$
  - $\text{O}_3/\text{H}_2\text{O}_2$
  - cold & dil.  $\text{KMnO}_4/\text{OH}^-$

## INTEGER VALUE

9. A solid has a structure in which *X* atoms are located at cubic corners of unit cell, *O* atoms are at the edge centres and *Y* atoms at cube centre. Then the formula of the compound is  $\text{X}_a\text{Y}_b\text{O}_c$ . If two *O* atoms are missing from any of two edge centres per unit cell, then the molecular formula is  $\text{X}_x\text{Y}_y\text{O}_z$ . Then, find the value of  $(x + y + z) - (a + b + c)$ .
10. Consider the following complex :  
dichlorobis(ethylenediamine)chromium(III)chloride  
Number of unpaired electrons in complex = *X*  
One mole complex  $\xrightarrow[\text{(excess)}]{\text{AgNO}_3}$  *Y* mole of  $\text{AgCl}$ .  
Total stereoisomeric forms of above complex = *Z*  
The sum of *X*, *Y* and *Z* is

●●

## The Nobel Prize in Chemistry 2018

The Nobel Prize in Chemistry 2018 was divided, one half awarded to Frances H. Arnold for the directed evolution of enzymes, the other half jointly to George P. Smith and Sir Gregory P. Winter for the phage display of peptides and antibodies.



Frances H. Arnold

California Institute of Technology, USA



George P. Smith

University of Missouri, USA



Sir Gregory P. Winter

MRC Laboratory of Molecular Biology, UK

## They harnessed the power of evolution

The power of evolution is revealed through the diversity of life. The 2018 Nobel Laureates in Chemistry have taken control of evolution and used it for purposes that bring the greatest benefit to humankind. Enzymes produced through directed evolution are used to manufacture everything from biofuels to pharmaceuticals. Antibodies evolved using a method called phage display can combat autoimmune diseases and, in some cases, cure metastatic cancer.

Since the first seeds of life arose around 3.7 billion years ago, almost every crevice on Earth has filled with different organisms. Life has spread to hot

springs, deep oceans and dry deserts, all because evolution has solved a number of chemical problems. Life's chemical tools – proteins – have been optimised, changed and renewed, creating incredible diversity.

This year's Nobel Laureates in Chemistry have been inspired by the power of evolution and used the same principles – genetic change and selection – to develop proteins that solve mankind's chemical problems. One half of this year's Nobel Prize in Chemistry is awarded to Frances H. Arnold. In 1993, she conducted the first directed evolution of enzymes, which are proteins that catalyse chemical reactions. Since then, she has refined the methods that are now routinely used to develop new catalysts. The uses of Frances Arnold's enzymes include more environmentally friendly manufacturing of chemical substances, such as pharmaceuticals, and the production of renewable fuels for a greener transport sector.

The other half of this year's Nobel Prize in Chemistry is shared by George P. Smith and Sir Gregory P. Winter. In 1985, George Smith developed an elegant method known as phage display, where a bacteriophage – a virus that infects bacteria – can be used to evolve new proteins. Gregory Winter used phage display for the directed evolution of antibodies, with the aim of producing new pharmaceuticals. The first one based on this method, adalimumab, was approved in 2002 and is used for rheumatoid arthritis, psoriasis and inflammatory bowel diseases. Since then, phage display has produced antibodies that can neutralise toxins, counteract autoimmune diseases and cure metastatic cancer. We are in the early days of directed evolution's revolution which, in many different ways, is bringing and will bring the greatest benefit to humankind.



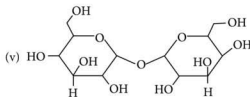
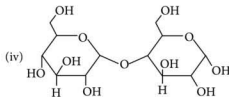
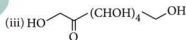
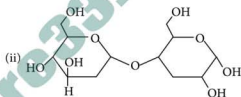
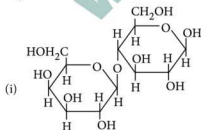
# CONCEPT BOOSTER

Dear students, you are always special for me and this is why I become always happy when I connect with you all. First of all I wish you all a HAPPY DIPAWALI & CHHATH PUJA in advance. Hope you had a great time during DURGA PUJA & NAVRATRI. I also believe that side by side you are preparing with your full efforts for JEE MAIN Exam. Biomolecules is a chapter which some students ignore but I believe this is a scoring portion and by knowing a few tricks you can easily solve questions from this chapter with this in focus, I have given 20 questions of different tastes which will help you to grip this chapter. Hope you all will like it. Have a great time.

\*Arunava Sarkar

## BIOMOLECULES

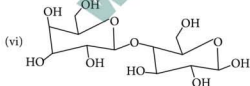
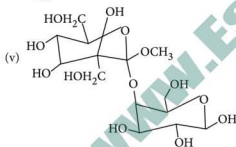
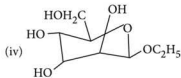
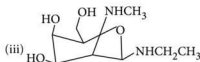
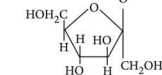
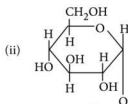
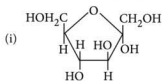
- Glucose reacts with acetic anhydride to form
  - monoacetate
  - tetraacetate
  - pentaacetate
  - hexaacetate.
- The number of chiral carbons in  $\beta$ -D-(+)-glucose is
  - five
  - six
  - three
  - four.
- Glucose reacts with excess of phenylhydrazine and forms
  - glucosazone
  - glucose phenylhydrazone
  - glucose oxime
  - sorbitol.
- $\alpha$  and  $\beta$ -glucose differ in the orientation of  $-\text{OH}$  group around
  - $\text{C}_1$
  - $\text{C}_2$
  - $\text{C}_3$
  - $\text{C}_4$
- Out of the following structures which are reducing sugars?



- Only (i), (ii)
- Only (ii), (iii)
- (i), (ii), (iii) & (iv)
- All of these

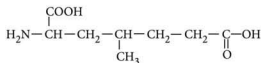
\*Institute of Chemistry (IOC)- Asansol, Durgapur, Dhanbad, Burdwan, Kolkata, Jamshedpur, Bokaro, Patna

6. Which of the following sugars will react with  $\text{Ag}^+$ ?

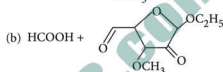
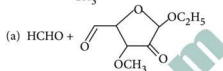
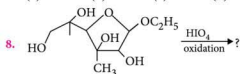


- (a) (i), (ii) and (iii) (b) (ii), (v) and (vi)  
(c) (iii), (v) and (vi) (d) (i), (v) and (vi)

7. What will be the net charge of following species at  $\text{pH} = 14$ ?

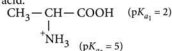


- (a) +1 (b) +2 (c) -1 (d) -2



- (d) None of these

9. Find out the isoelectric point of the following amino acid.

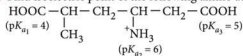


- (a) 3.8 (b) 4.2  
(c) 2.8 (d) None of these

10. For an amino acid, isoelectric point is 5.8. At what  $\text{pH}$ , maximum concentration of zwitter ion is found?

- (a)  $\text{pH} > 5.8$  (b)  $\text{pH} < 5.8$   
(c)  $\text{pH} = 5.8$  (d)  $\text{pH} = 2 \times 5.8$

11. Find isoelectric point of the following amino acid.



- (a) 4.5 (b) 5 (c) 6 (d) 4

12. How can you differentiate between *D*-glucose and *D*-fructose?

- (a) Using Brady's reagent  
(b) Using Tollens' reagent  
(c) Using  $\text{Br}_2 + \text{H}_2\text{O}$  (d) None of these

# FULLY LOADED & COMPLETELY UPDATED

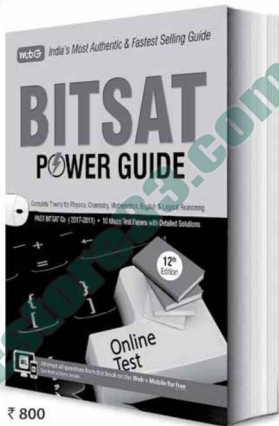
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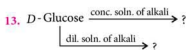
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- (a) Both the products are same.  
 (b) Both the products are different  
 (c) No reaction in case of dil. solution.  
 (d) No reaction in case of conc. solution.

14. For an amino acid lowest solubility is found in water

- (a) in acidic medium (b) in basic medium  
 (c) at pH = 7 (d) at isoelectric point.

15. Identify the peptide linkage.

- (a)  $\begin{array}{c} \text{—C—NH—} \\ || \\ \text{O} \end{array}$  (b)  $\begin{array}{c} \text{—N=C—O—} \\ | \\ \text{R} \end{array}$   
 (c)  $\begin{array}{c} \text{—C=N—H} \\ | \\ \text{R} \end{array}$  (d)  $\begin{array}{c} \text{—C—O—N—} \\ | \quad | \\ \text{H} \quad \text{H} \end{array}$

16. Which of the following is a non-reducing sugar?

- (a) Mannose (b) Glucose  
 (c) Fructose (d) Sucrose

17. Glycosidic linkage is

- (a) an amide linkage (b) an ester linkage  
 (c) an ether linkage (d) an amine linkage.

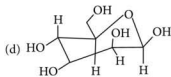
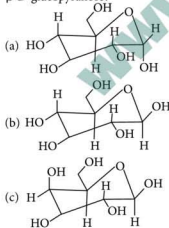
18. How many mole(s) of phenylhydrazine is/are required to react with glucose to give osazone?

- (a) 1 (b) 2 (c) 3 (d) 4

19. Osazone  $\xrightarrow{\text{PhCHO/H}^+}$  ?

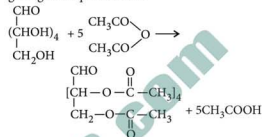
- (a) Osone (b) Osione  
 (c) Osanone (d) None of these

20. Which one is the correct structure of  $\beta$ -D-glucopyranose?



## SOLUTIONS

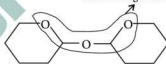
1. (c): Glucose has five -OH groups. Glucose on reaction with 5 molecules of acetic anhydride gives glucose pentaacetate.



2. (a) 3. (a) 4. (a)

5. (c): (1) For a disaccharide, if the skeleton is as below, it'll be non-reducing as reducing centres are destroyed here.

Three oxygen atoms back to back make the sugar non-reducing



If other factors are fine, then this trick will work always.

(2) Try to check out whether -CHO can be formed in open chain format or not. Try to think whether mild oxidation or hydrolysis can generate -CHO in open chain. This trick will even be useful if you get a question like "which of the following sugars will react (or will not react with  $\text{AgNO}_3$  or  $\text{Ag}^+$ ; follow the next question).

So, using the above two tricks, correct option is (c).

(iii) is a reducing sugar because there is a fair chance of formation of -CHO group through the oxidation of - $\text{CH}_2\text{OH}$  group. Moreover simple keto groups are present into it. (-CHOH also gives  $\text{—C=O—}$  on oxidation).



(v) can't be a reducing sugar.

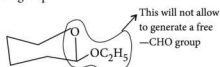
6. (d): To be able to understand the complete concept, let us analyse each structure.

(i) It is  $\alpha$ -D-fructofuranose. It is a ketone. It is of course reducing and hence will reduce Tollens' reagent i.e. will react with  $\text{Ag}^+$ .

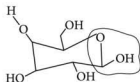
(ii) It is Haworth projection of sucrose. You better know that sucrose is non-reducing in nature. So, it'll not react with  $\text{Ag}^+$ .

(iii) If you hydrolyse the structure, you are not ended up with a free  $-\text{CHO}$  group. Rather, you are ended up with  $-\text{C}(=\text{O})-\text{NH}-$  group. So, it'll not react with  $\text{Ag}^+$ .

(iv) Here also you are not ended up with free  $-\text{CHO}$  group.



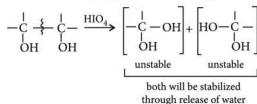
(v) At the lower right corner end, a free  $-\text{CHO}$  will be available after hydrolysis. It'll react with  $\text{Ag}^+$ .



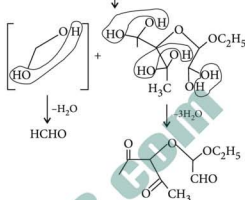
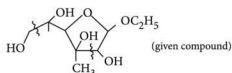
(vi) same pinch here

7. (d): At  $\text{pH} = 14$ , the medium is completely basic/alkaline. So, no change will be for  $-\text{NH}_2$  but  $-\text{COOH}$  will remain in the form of  $-\text{COO}^-$  (carboxylate ion). As there are two  $-\text{COOH}$  groups, hence two  $-\text{COO}^-$  will be present. So, net charge will be  $-2$ .

8. (c): You know that function of  $\text{HIO}_4$  is to break down the glycol compounds (to adjacent carbons hold two  $-\text{OH}$  groups) in the following manner:



Hence, for the following compound we'll have,



$$\begin{aligned} 9. \text{ (d): Isoelectric point} &= \frac{\text{p}K_{a1} + \text{p}K_{a2}}{2} \\ &= \frac{5+2}{2} = 3.5 \end{aligned}$$

10. (c): It is the  $\text{pH}$  at isoelectric point at which we have supposed to get the maximum concentration of zwitter ion.

11. (a): The trick is  $-\text{NH}_2$  group is present in the  $^+\text{NH}_3$  form. So, no considerable contribution from this group (at acidic medium specially).

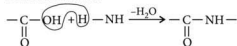
$$\therefore \text{Isoelectric point} = \frac{4+5}{2} = 4.5$$

12. (c): D-glucose on reaction with  $\text{Br}_2/\text{H}_2\text{O}$  gives D-gluconic acid but D-fructose doesn't give.

13. (b)

14. (d): As at isoelectric point, concentration of zwitter ion is maximum therefore solubility is lowest.

15. (a): Obviously you can show the peptide linkage formation as this:



16. (d)

17. (c)

18. (c)

19. (a)

20. (b)





# ADVANCED CHEMISTRY BLOC

## Story of Scrooge McDuck & Polymorphism

Mukul C. Ray, Odisha

Scrooge McDuck once purchased a coal mine paying a hefty price. His grandnephews Huey, Dewey and Louie opposed the investment. An adventurer, explorer and businessman Scrooge did not pay any heed to the kids' remark. Surprisingly, uncle Scrooge sowed seeds of peanuts on the land. This made the kids even more mocking. "Uncle, you could have purchased an agricultural land instead for this purpose, why such a costly coal mine" said the kids. As usual, Scrooge gave a stylish laugh and showed confidence in his decision. The plants grew and matured. Elephants from the nearby forest approached in herd and started digging the roots of small plants to find the peanuts. The kids rushed to uncle to inform him about the matter. A smiling Scrooge, rather laughing Scrooge did not pay any attention again. After demolishing the peanut plants the animals went back. Pieces of diamonds appeared in the land.

- This famous Walt Disney's cartoon teaches the pressure dependent polymorphism observed in coal in this hilarious way. Though the theme is overstated but it presents polymorphism in a way, which you probably will never forget. The fact is coals cannot be converted to diamonds even under pressure artificially, though graphite can be. Coal contains various impurities; diamond, on the other hand, is the pure form of elemental carbon. The lowest pressure you would need to have would be about 10 GPa and temperature about 4000 K. That's almost a hundred thousand times the normal atmospheric pressure, at a temperature at which basically everything melts.
- It is natural for pressure to induce polymorphic phase changes.
- Temperature dependent polymorphism is common. Many metals and some non-metals may have different types of crystal structures in the solid state depending on temperature. Such crystals are

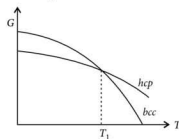
also called allotropic modifications and are usually designated as  $\alpha$ ,  $\beta$  and  $\gamma$  etc.

The stability of allotropic modifications at definite temperature and pressure is determined by the thermodynamic potential.

$$G = H - TS$$

The modification having a lower algebraic value of thermodynamic potential at a given temperature is more stable. This lowering of potential can be achieved by lowering enthalpy or raising entropy.

In metallic crystal, the close packed structures are *hcp* and *fcc* (or *ccp*). These two modifications have coordination number 12 and lower enthalpy value. They are stable at lower temperature. The looser *bcc*, with coordination number 8 has higher entropy. As you can see from the graph, beyond temperature  $T_1$ , *bcc* structure with lower  $G$  is favoured. This explains stability of *bcc* structures in many metals like Ti, Zr, Fe, U at elevated temperature.



Around 30 metals, show temperature dependent polymorphism. Iron is a unique element. It has a *bcc* modification (alpha iron) in lower temperature range, below 912 °C. Then it changes to *ccp* (gamma iron) and then finally *bcc* (delta iron) again at high temperature before it melts to liquid. The low temperature *bcc* in case of iron is because of reasons, which are beyond the scope of this discussion.



- When CsCl (coordination number = 8) is sublimed on to a rough surface it crystallises in the rock salt (coordination number = 6) structure.

The stability of allotropic modifications may change due to changes in the type of bond. For example, the tin modification with diamond type lattice, called alpha tin, is stable at low temperature owing to high energy of covalent bond, and therefore, low enthalpy. On heating it changes to beta tin, which has weaker metallic bond.

Some polymorphous transformations occur under the effect of pressure and temperature. Under very high pressure, iron has a low temperature modification with hcp lattice. An increase in pressure at low temperature can change the less closely packed modification into

close packed structure. As it has been observed for Ge, Si and alpha tin, application of a high pressure can change their covalent crystals with diamond type lattice (coordination number = 4) into metallic crystal with tetragonal body centered lattice (coordination number = 8). NaCl (coordination number = 6) under high pressure changes to CsCl (coordination number = 8) structure.

Calcite is a carbonate mineral and is the most stable polymorph of calcium carbonate. Other polymorphs of calcium carbonate are aragonite and vaterite.

By virtue of non-directive nature of metallic bonds and closed packed structures, metallic crystals are more plastic and less hard than the covalent crystals.



## UNSCRAMBLE ME

Unscramble the words given in column I and match them with their explanations in column II.

### Column I

- SICOSIDME
- GSNIINRTE
- IDATOCAL
- YPRENOH
- DUNIRIH
- NGNENILUT
- AXORUPB
- NPOORIC
- NPOULGUM
- DREOERHPOIS

### Column II

- A non-enzymatic chemical secreted from the leech that prevents blood clotting.
- This diagram is often used to grab quickly an idea of which species predominates at specific pH and oxidation-reduction conditions.
- The process by which a particle or a set of particles crosses a barrier on its potential energy surface without having the energy required to surmount this barrier.
- A reaction (actual or hypothetical) in which the types of bonds which are made in forming the products are the same as those which are broken in the reactants.
- A biological substance secreted by various cells whose physiological activity is restricted to the vicinity of its release. It is often referred to as local hormone.
- Generic term for Fe(III) complexing compounds released into the medium by bacteria for the purpose of scavenging iron.
- Any process by which the normal alternating donor and acceptor reactivity pattern of a chain, which is due to the presence of O or N heteroatoms, is interchanged.
- It refers to the elementary particle present in cosmic radiations. Mass of it is 2185 times that of an electron.
- It refers to a process of bonding by atomic or molecular diffusion wherein powders are heated under pressure but at a temperature below the melting point.
- These dyes are a type of azo dyestuffs which can form covalent bonds to cellulose by reactive groups.

Readers can send their responses at [editor@mtg.in](mailto:editor@mtg.in) or post us with complete address by 10<sup>th</sup> of every month. Names of solution senders will be published in next issue.

# YOU ASK WE ANSWER

**Do you have a question that you just can't get answered?**

Use the vast expertise of our MTG team to get to the bottom of the question. From the serious to the silly, the controversial to the trivial, the team will tackle the questions, easy and tough.

The best questions and their solutions will be printed in this column each month.

1. According to MOT, why should combining atomic orbitals have the same energy?

(Surajit Chakraborty, Assam)

**Ans.** The combining atomic orbitals must have same or nearly same energy, i.e., comparable energy. When the atomic orbitals have the same energy, the interaction is strong and the resulting molecular orbitals have energies lower (bonding) and higher (antibonding) than that of the original atomic orbitals.

When the two atomic orbitals have quite different energies, the interaction is weak. The change in the energy of electrons upon formation of molecular orbitals is small and the net reduction in energy of the electrons is too small for significant bonding.

For example, for homonuclear diatomic molecule,  $A_2$ , 1s atomic orbital of one atom can combine with 1s atomic orbital of another atom or 2s can combine with 2s, 2p with 2p and so on. 1s cannot combine significantly with 2s (although 1s and 2s orbitals have the same symmetry) or 2s cannot combine with 2p as the energy difference is appreciably high. However, such combination can take place for heteronuclear diatomic molecules, AB, if the energy difference is not very high.

2. Why is ice slippery?

(S. Krishnamurthy, Telangana)

**Ans.** A thin layer of liquid water makes ice slippery and not directly the ice itself. Liquid water naturally forms on the surface of ice, even at very low temperature. Water on a smooth surface is slippery because water is a low viscosity liquid. As such, there are no permanent intermolecular bonds in liquid water and the transient intermolecular bonds are weak. This means that water molecules can move about freely, slide pass each other easily.


3. Why is propane stored in household tanks but natural gas is not?

(James Joseph, Kerala)

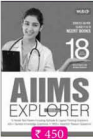
**Ans.** In order to get a useful amount of gaseous fuel into a reasonably sized tank, we have to liquefy it. Some fuels are easier to liquefy than others. Propane has a boiling point of  $-42^\circ\text{C}$  at atmospheric pressure, but methane (natural gas), has a boiling point of  $-162^\circ\text{C}$  at atmospheric pressure. This means that methane has to be cooled to a much lower temperature than propane in order to be turned to a liquid that can be stored in a tank. Propane molecules consist of three carbon atoms bonded in a chain with eight hydrogen atoms bonded to these carbon atoms. In contrast, a methane molecule is just one carbon atom bonded to four hydrogen atoms. Methane molecules have a high degree of symmetry.

Methane symmetry and lack of a permanent electric dipole, means that its molecules can only bond through a much weaker effect known as the London dispersion force or the van der Waals' force. Because this bonding mechanism is so weak, the methane molecules have to be cooled to a low temperature until they are still enough to bond and form a liquid. In contrast, propane does not require as low temperature to liquefy.


Household propane is not usually kept in a liquid state by a low temperature. Instead, high pressure is used. In order to keep propane a liquid at room temperature ( $21^\circ\text{C}$ ), it has to be held in a tank at a pressure of about 850 kPa. This can be accomplished with a strong metal tank. In contrast, to keep methane a liquid at room temperature requires a tank that can maintain a pressure of about 32,000 kPa. Household metal tanks cannot withstand this pressure. In short, methane is not stored in household tanks because the symmetry of its molecule makes it hard to liquefy.



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# GEAR UP FOR JEE MAIN 2019

Exam Dates : Between 6<sup>th</sup> to 20<sup>th</sup> January and between 6<sup>th</sup> to 20<sup>th</sup> April 2019

- To what extent must a given solution containing 40 mg  $\text{AgNO}_3$  per mL be diluted to yield a solution containing 16 mg  $\text{AgNO}_3$  per mL?
  - Each mL must be diluted to 2.5 mL.
  - To each mL of solution 2.5 mL of water should be added.
  - To 1.5 mL of solution 2 mL of water should be added.
  - To 1.5 mL of solution 1.5 mL of water should be added.
- Identify the incorrect statement.
  - The order of basic character of the following oxides is  $\text{NiO} < \text{MgO} < \text{SrO} < \text{K}_2\text{O} < \text{Cs}_2\text{O}$ .
  - $\text{Be}(\text{OH})_2$  is a stronger base than  $\text{Ba}(\text{OH})_2$ .
  - The order of the ionic character of the following chlorides is  $\text{BeCl}_2 < \text{MgCl}_2 < \text{CaCl}_2 < \text{SrCl}_2 < \text{BaCl}_2$ .
  - $\text{Ca}(\text{OH})_2$  is more soluble in water than  $\text{Mg}(\text{OH})_2$ .
- The work done in an open vessel at 300 K, when 112 g iron reacts with dil. HCl is
  - 1.2 kcal
  - 0.6 kcal
  - 0.3 kcal
  - 0.2 kcal
- $\text{MnO}_4^{2-}$  undergoes disproportionation reaction in acidic medium but  $\text{MnO}_4^-$  does not because
  - in  $\text{MnO}_4^{2-}$ , Mn is in intermediate oxidation state
  - in  $\text{MnO}_4^-$ , Mn is in lowest oxidation state
  - in  $\text{MnO}_4^-$ , Mn is in intermediate oxidation state
  - none of these.
- Consider the following sequence of reactions :
 
$$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH} \xrightarrow[573\text{ K}]{\text{Cu}} \text{A} \xrightarrow[\text{Ether}]{\text{HBr}} \text{B} \xrightarrow{\text{Mg}} \text{C} \xrightarrow{\text{H}_2\text{O}} \text{D}$$
 Here D is
  - $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$
  - $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$
  - $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$
  - $\text{CH}_3\text{CH}_2\text{CH}_2\text{I}$
- A white sodium salt dissolves readily in water to give a solution which is neutral to litmus. When silver nitrate solution is added to the solution, a white precipitate is obtained which does not dissolve in dilute  $\text{HNO}_3$ . The anion of the sodium salt could be
  - $\text{CO}_3^{2-}$
  - $\text{Cl}^-$
  - $\text{SO}_4^{2-}$
  - $\text{S}^{2-}$
- Which of the following statements about enzymes is/are true?
  - Enzymes lack in nucleophilic group.
  - Enzymes are highly specific both in binding chiral substrates and in catalysing their reactions.
  - Enzymes catalyse chemical reactions by lowering the activation energy.
  - Pepsin is a proteolytic enzyme.
  - (i) and (iv) only
  - (ii) and (iii) only
  - (c) (ii), (iii) and (iv) only
  - (i) only
- For some bonds, the bond energy values are given below. Predict the correct polarity order.
 

Bond	Bond Energy (kJ/mol)
A-D	416
A-C	432
A-B	570

  - A-D > A-C > A-B
  - A-B > A-C > A-D
  - A-C > A-B > A-D
  - A-D > A-B > A-C
- An electric current is passed through silver nitrate solution using silver electrodes. 10.79 g of silver was found to be deposited on the cathode. If the same amount of electricity is passed through copper sulphate solution using copper electrodes, the weight of copper deposited on the cathode is
  - 1.6 g
  - 2.3 g
  - 3.2 g
  - 6.4 g
- Which of the following pairs are incorrectly matched?
  - Sucrose – Monosaccharide
  - Fructose – Aldose sugar
  - Glucose – Mutarotation
  - Sucrose – Reducing sugar
  - 2, 3 and 4
  - 1, 2 and 3
  - 1, 2 and 4
  - 2 and 4 only
- 20%  $\text{N}_2\text{O}_4$  molecules are dissociated in a sample of gas at 27 °C and 760 torr. The density of the equilibrium mixture is
  - 1.56 g  $\text{L}^{-1}$
  - 3.116 g  $\text{L}^{-1}$
  - 4.58 g  $\text{L}^{-1}$
  - can't be calculated.

12. Match list I with list II and select the correct answer.

**List I**  
(Chemotherapeutic agents)

1. Antibiotic
2. Antiseptic
3. Analgesic
4. Tranquillizer

**List II**  
(Examples)

- A. Chloroxylenol
- B. Chlorpheniramine
- C. Chloramphenicol
- D. Diclophenac sodium
- E. Veronal

- (a) 1-A, 2-C, 3-D, 4-E
- (b) 1-B, 2-A, 3-D, 4-E
- (c) 1-B, 2-C, 3-E, 4-D
- (d) 1-C, 2-A, 3-D, 4-E

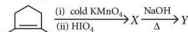
13. Oxalic acid reacts with concentrated  $\text{H}_2\text{SO}_4$  to give a mixture of two gases. When this mixture is passed through caustic potash, one of the gases is absorbed. What is the product formed by the absorbed gas with caustic potash?

- (a)  $\text{K}_2\text{SO}_4$
- (b)  $\text{KHCO}_3$
- (c)  $\text{K}_2\text{CO}_3$
- (d) KOH

14. How far from the nucleus is the electron in a hydrogen atom if it has energy of  $-0.850 \text{ eV}$ ?

- (a)  $2.39 \text{ \AA}$
- (b)  $5.69 \text{ \AA}$
- (c)  $8.46 \text{ \AA}$
- (d)  $9.38 \text{ \AA}$

15. In the given sequence of reactions, product (Y) is



- (a)
- (b)
- (c)
- (d)

16. Which of the following species has  $dsp^2$ -hybridization?

- (a)  $[\text{Ni}(\text{CO})_4]$
- (b)  $[\text{Ni}(\text{CN})_4]^{2-}$
- (c)  $[\text{Zn}(\text{NH}_3)_4]^{2+}$
- (d)  $[\text{CuCl}_4]^{2-}$

17. Marbles of diameter  $2 \text{ cm}$  are to be placed either inside or upon an equilateral triangle (edge length  $4 \text{ cm}$ ) drawn on a floor. The maximum number of marbles that can be accommodated is/are

- (a) 1
- (b) 2
- (c) 3
- (d) 6

18. Bauxite ore is made up of  $\text{Al}_2\text{O}_3 + \text{SiO}_2 + \text{TiO}_2 + \text{Fe}_2\text{O}_3$ . This ore is treated with conc. NaOH solution at  $500 \text{ K}$  and  $35 \text{ bar}$  pressure for few hours and filtered when hot. In the filtrate, the species present is/are

- (a)  $\text{NaAl}(\text{OH})_4$  only
- (b)  $\text{Na}_2\text{Ti}(\text{OH})_6$  only
- (c)  $\text{NaAl}(\text{OH})_4$  and  $\text{Na}_2\text{SiO}_3$  both
- (d)  $\text{Na}_2\text{SiO}_3$  only

19. The reaction between HI and  $\text{C}_2\text{H}_4$  in  $\text{C}_2\text{H}_5\text{OH}$  gives 'predominantly'  $\text{C}_2\text{H}_5\text{I}$ , whereas the reaction with HCl and  $\text{C}_2\text{H}_4$  in  $\text{C}_2\text{H}_5\text{OH}$  gives predominantly  $(\text{C}_2\text{H}_5)_2\text{O}$ . Identify the correct order of nucleophilicity of the nucleophiles involved in the above reactions.

- (a)  $\text{I}^- > \text{EtO}^- > \text{Cl}^-$
- (b)  $\text{I}^- > \text{Cl}^- > \text{EtOH}$
- (c)  $\text{EtOH} > \text{Cl}^- > \text{I}^-$
- (d)  $\text{I}^- > \text{EtOH} > \text{Cl}^-$

20. When a vapour at atmospheric pressure was gradually heated from  $25^\circ\text{C}$  its colour was found to deepen at first and then fade as the temperature was raised above  $160^\circ\text{C}$ . At  $600^\circ\text{C}$ , the vapour was almost colourless, but its colour deepened when the pressure was raised at this temperature. The vapour originally present was

## These jobs will soon be extinct

If you are planning your career, please beware of these 10 jobs. According to the World Economic Forum's (WEF) the future of jobs report 2018, the world will lose 75 million jobs by 2022, all these jobs are listed in top 10 declining job roles.

- Data entry clerks
- Accounting, bookkeeping and payroll clerks
- Administrative and executive secretaries
- Assembly and factory workers
- Client information and customer service workers
- Business services and administration managers
- Accountants and auditors
- Material-recording and stock-keeping clerks
- General and operations managers
- Postal service clerks

Thanks to technological advancement, these roles will be obsolete and newer roles will be generated. According to WEF, 133 million jobs will be created by 2022 and the emerging job roles which can be most relevant in the future are —

- Data analyst and scientists
- AI and Machine learning specialists
- General and operation managers
- Software and applications developers and analysts
- Sales and marketing professionals
- Big data specialist
- Digital transformation specialists
- New technology specialists
- Organisational development specialists
- Information technology services

- (a) the bromine  
(b) a mixture of nitrogen dioxide and dinitrogen tetroxide  
(c) pure nitrogen dioxide  
(d) pure dinitrogen tetroxide.
21. A 0.001 molal solution of  $\text{Pt}(\text{NH}_3)_4\text{Cl}_4$  in water had a freezing point depression of  $0.0054^\circ\text{C}$ . If  $K_f$  for water is  $1.80^\circ\text{C m}^{-1}$ , the correct formulation for the above molecule is  
(a)  $[\text{Pt}(\text{NH}_3)_3\text{Cl}_3]\text{Cl}$  (b)  $[\text{Pt}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}_2$   
(c)  $[\text{Pt}(\text{NH}_3)_4]\text{Cl}_4$  (d)  $[\text{Pt}(\text{NH}_3)_4\text{Cl}_4]$
22. Arrange *m*-nitrochlorobenzene (I), 2,4-dinitrochlorobenzene (II), *p*-nitrochlorobenzene (III) according to reactivity with sodium ethoxide.  
(a)  $\text{I} > \text{II} > \text{III}$  (b)  $\text{III} > \text{I} > \text{II}$   
(c)  $\text{II} > \text{III} > \text{I}$  (d)  $\text{II} = \text{III} > \text{I}$
23. Which of the following pairs is expected to exhibit the same colour?  
(a)  ${}_{58}\text{Ce}^{3+}$ ,  ${}_{67}\text{Ho}^{3+}$  (b)  ${}_{60}\text{Nd}^{3+}$ ,  ${}_{68}\text{Er}^{3+}$   
(c)  ${}_{61}\text{Pm}^{3+}$ ,  ${}_{69}\text{Tm}^{3+}$  (d)  ${}_{62}\text{Sm}^{3+}$ ,  ${}_{70}\text{Yb}^{3+}$
24. 0.1 M acetic acid solution is titrated against 0.1 M NaOH solution. What should be the difference in pH between 1/4 and 3/4 stages of neutralisation of acid?  
(a)  $-2 \log 3/4$  (b)  $2 \log 1/4$   
(c)  $\log 1/3$  (d)  $-2 \log 3$
25. Sample of water has hardness 77.5 ppm  $\text{Ca}^{2+}$ . If this is passed through an ion exchange column where  $\text{Ca}^{2+}$  is replaced by  $\text{H}^+$ , what is the pH of water after it has been so treated?  
(a) 2.41 (b) 1.41 (c) 4.41 (d) 4.27
26. Which of the following molecules/species has minimum number of lone pairs on its central atom?  
(a)  $\text{BrF}_3$  (b)  $\text{BrF}_4^-$  (c)  $\text{XeF}_2$  (d)  $\text{I}_3^-$
27. 0.759 g of a silver salt of a dibasic organic acid on ignition left 0.463 g metallic silver. The equivalent weight of acid is  
(a) 50 (b) 65 (c) 70 (d) 85
28. Sometimes yellow turbidity appears while passing  $\text{H}_2\text{S}$  gas even in the absence of group II radicals. This is because of  
(a) sulphur is present in the mixture as impurity  
(b) group IV radicals are precipitated as sulphides  
(c) the oxidation of  $\text{H}_2\text{S}$  gas by some acid radicals  
(d) group III radicals are precipitated as hydroxides.
29. The activation energies of two reactions are  $E_a$  and  $E'_a$  with  $E_a > E'_a$ . If the temperature of the reacting systems is increased from  $T_1$  to  $T_2$ , predict which alternative is correct.  
 $K'$  are rate constants at higher temperature. Assume  $A$  being same for both the reactions.  
(a)  $\frac{k'_1}{k_1} = \frac{k'_2}{k_2}$  (b)  $k_1 < k_2$  and  $k'_1 < k'_2$   
(c)  $k_1 > k_2$  and  $k'_1 > k'_2$  (d)  $\frac{k'_1}{k_1} < \frac{2k'_2}{k_2}$
30. The correct statements about Curtius and Hoffmann degradation are  
1. both involve nitrene reaction intermediate  
2. both involve intramolecular alkyl shift  
3. Curtius reaction gives primary amine while Hoffmann degradation gives secondary amine  
4. Curtius reaction uses  $\text{NaN}_3$  while Hoffmann degradation uses  $\text{NaOBr}$ .  
(a) 1, 2, 3 (b) 1, 2, 4 (c) 2, 3, 4 (d) 1, 3, 4

## SOLUTIONS

1. (a) :  $N_1 V_1 = N_2 V_2$   
 $\frac{40}{170} \times 10^{-3} x_1 = \frac{16}{170} \times 10^{-3} x_2$   
 $x_2 = \frac{40}{16} x_1 = 2.5 x_1$
2. (b)
3. (a) :  $\text{Fe} + 2\text{HCl} \longrightarrow \text{FeCl}_2 + \text{H}_2$

Mole of  $\text{Fe} = \frac{112}{56} = 2$ ; mole of  $\text{H}_2$  formed = 2

Now work done =  $P(V_2 - V_1)$ ;  $V_2 = V_{\text{H}_2}$  and  $V_1 = 0$  (for solid and liquid)

$$= P \cdot V_{\text{H}_2} = P \cdot \frac{nRT}{p} = nRT$$

$$= 2 \times 2 \times 300 = 1200 \text{ cal} = 1.2 \text{ kcal}$$

## Solution Senders of Chemistry Musing

## Set - 62

- Shiv Prakash Gupta, Uttar Pradesh

## Set - 63

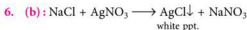
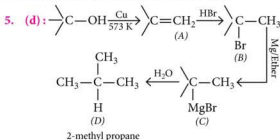
- Abhinav Malhotra, New Delhi
- K. Shivkumar, Andhra Pradesh

## Solution Senders of Puzzle Corner

- Neeraj Kataria, Uttar Pradesh
- Ishita Sen, West Bengal

4. (a) : In  $\text{MnO}_4^{2-}$ , the oxidation number of Mn is +6. It can increase its oxidation number to +7 or decrease its oxidation number to +4, +3, +2, 0. Hence, it undergoes disproportionation reaction in acidic medium.

In  $\text{MnO}_4^-$ , Mn is in its highest oxidation state, i.e., +7. It can only decrease its oxidation number. Hence, it cannot undergo disproportionation reaction.



7. (c) : Enzymes are highly specific in nature and catalyse reaction by lowering the activation energy. Pepsin is a proteolytic enzyme.

8. (b) : More the polarity, more is the bond energy.

9. (c) : Number of equivalents of silver formed = number of equivalents of copper formed

In  $\text{AgNO}_3$ , Ag is in +1 oxidation state.

In  $\text{CuSO}_4$ , Cu is in +2 oxidation state.

$$\text{Equivalent weight of Ag} = \frac{108}{1} = 108 \text{ g equiv}^{-1}$$

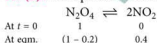
$$\text{Equivalent weight of Cu} = \frac{63.6}{2} = 31.8 \text{ g equiv}^{-1}$$

$$\frac{w_1}{w_2} = \frac{E_1}{E_2}$$

$$\therefore \frac{10.79}{w_{\text{Cu}}} = \frac{108}{31.8} \text{ or } w_{\text{Cu}} = \frac{10.79 \times 31.8}{108} = 3.2 \text{ g}$$

10. (c)

11. (b) : The equilibrium established is

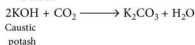
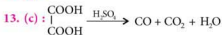


$$\therefore \text{Molar mass of mixture} = \frac{0.8 \times 92 + 0.4 \times 46}{1.2} = 76.66$$

$$\text{Using ideal gas equation, } PV = \frac{w}{M} RT$$

$$\text{or } d = \frac{w}{V} = \frac{PM}{RT} = \frac{76.66 \times 1}{0.082 \times 300} = 3.116 \text{ g L}^{-1}$$

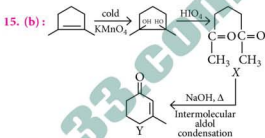
12. (d)



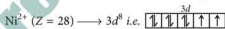
$$14. (c) : E_n = -\frac{Z^2}{n^2} \times 13.6$$

$$\therefore -\frac{Z^2}{n^2} \times 13.6 = -0.85 \text{ or } n = 4 \quad (\because Z = 1)$$

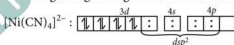
$$r = \frac{n^2}{Z} \times 0.529 = \frac{16}{1} \times 0.529 = 8.46 \text{ \AA}$$



16. (b) : Oxidation state of Ni in  $[\text{Ni}(\text{CN})_4]^{2-} = +2$

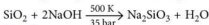
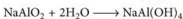
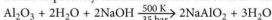


$\text{CN}^-$  being strong field ligand forces electrons to pair up.

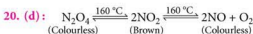


17. (d) :

18. (c) : In bauxite ore, only  $\text{Al}_2\text{O}_3$  and  $\text{SiO}_2$  react with conc. NaOH and forms sodium metaaluminate and silicate respectively. Aluminate further dissolves in water.



19. (d)



On heating the vapours, colour deepens due to conversion of colourless  $\text{N}_2\text{O}_4$  to brown coloured  $\text{NO}_2$ . But beyond  $160^\circ\text{C}$   $\text{NO}_2$  start converting to colourless mixture of  $\text{NO}$  and  $\text{O}_2$  thus now colour fades away.

But if pressure is increased to 600 °C then according to Le-Chatelier's principle, equilibrium will again shift towards brown coloured  $\text{NO}_2$  due to lesser number of moles and hence colour again deepens. Thus, originally vapours contain pure  $\text{N}_2\text{O}_4$ .

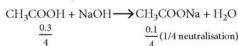
$$21. (b) : \Delta T_f = iK_f m \Rightarrow i = \frac{\Delta T_f}{K_f \cdot m} ; i = \frac{0.0054}{1.80 \times 0.001} = 3$$

It means 3 ions are produced on dissociation hence, formula must be  $[\text{Pt}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}_2$ .

22. (c) : Greater the number of electron withdrawing groups at *o*- and *p*-positions w.r.t. halogen more will be the reactivity towards nucleophilic substitution reactions. *m*-nitrochlorobenzene is less reactive than the *p*-nitrochlorobenzene since the  $-\text{NO}_2$  group at *m*-position can not stabilize the intermediate carbanion by resonance. Thus, the correct option is II > III > I.

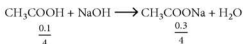
23. (b)

24. (d) : At  $\frac{1}{4}$  neutralisation



$$\therefore \text{pH}_1 = \text{p}K_a + \log \frac{1}{3}$$

At  $\frac{3}{4}$  neutralisation



$$\therefore \text{pH}_2 = \text{p}K_a + \log 3$$

$$\therefore \text{pH}_1 - \text{pH}_2 = \log \frac{1}{3} - \log 3 = -2 \log 3$$

$$25. (a) : \text{Ca}^{2+} + 2\text{RH} \longrightarrow \text{R}_2\text{Ca} + 2\text{H}^+$$

$$10^6 \text{ mL of H}_2\text{O has } 77.5 \text{ g Ca}^{2+} = \frac{77.5}{40} \text{ mole Ca}^{2+}$$

$$\Rightarrow 2 \times \frac{77.5}{40} \text{ mole H}^+$$

$$\therefore 10^3 \text{ mL of H}_2\text{O has } \text{H}^+ = 3.875 \times 10^{-3} \text{ M}$$

$$\text{pH} = -\log[\text{H}^+] = 2.41$$

26. (c)

$$27. (c) : \text{Eq. weight of silver salt} = \text{Eq. weight of Ag}$$

$$\frac{0.759}{E} = \frac{0.463}{108}$$

$$\therefore \text{Eq. weight of silver salt} = 177$$

$$\therefore \text{Eq. weight of acid} = 177 - 108 + 1 = 70$$

28. (c) : Turbidity is due to colloidal sulphur formed as a result of the oxidation of  $\text{H}_2\text{S}$  by some oxidising agent (radicals) present in the mixture.



29. (b) : More is energy of activation, lesser is rate constant ( $k = A e^{-E_a/RT}$ ).

Thus since  $E_a > E'_a$ ,  $k_1 < k_2$  and  $K_1 < K_2$

30. (b)



# 3 AMAZING FACTS YOU MUST KNOW

1



Thioacetone is considered to be one of the most smelliest compound. You can smell a drop of it from half kilometer away. In 1889, the whole city of Freiburg was evacuated due to accidental release of the chemical.



2



$$\text{Human Body} = \frac{6}{12.01} \rightarrow 9,000 \text{ pencils}$$

The human body contains enough carbon to provide 'Lead' (Graphite) for about 9,000 pencils.

3



THE TIPS OF YOUR FINGERS HAVE ENOUGH STRENGTH TO SUPPORT THE WEIGHT OF YOUR WHOLE BODY.



I CAN GET MYSELF ON MY FINGERTIPS!





6. (a): From the graph it is clear that the given reactions follow zero order kinetics.

For reaction I, slope =  $\tan 30^\circ = \frac{1}{\sqrt{3}} = k$

(a)  $[B]_t = k_1 t$ ;  $0.25 = \frac{1}{\sqrt{3}} t$ ;  $t = 0.25\sqrt{3}$

For reaction II, slope =  $\tan 60^\circ = \sqrt{3} = k$

$[D]_t = k_{II} t = \sqrt{3} \times 0.25 \times \sqrt{3} = 0.75 \text{ M}$

(b) If  $[C] = [A]$  then at that time  $[B] < [D]$

(c)  $t_{100\%} = \frac{a}{k}$  (for zero order)

$\frac{(t_{100\%})_I}{(t_{100\%})_{II}} = \frac{a_I}{a_{II}} \cdot \frac{k_{II}}{k_I} = \frac{0.5}{1} \times \frac{\sqrt{3}}{1/\sqrt{3}} = \frac{3}{2}$

(d)  $[A]_t = [A]_0 - k_1 t$  or  $[A]_t = 0.5 - \frac{1}{\sqrt{3}} t$

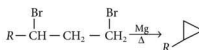
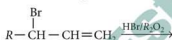
$[C]_t = [C]_0 - k_{II} t$  or  $[C]_t = 1 - \sqrt{3} t$

if  $[A]_t = [C]_t$

i.e.  $0.5 - \frac{1}{\sqrt{3}} t = 1 - \sqrt{3} t$  or  $(\sqrt{3} - \frac{1}{\sqrt{3}}) t = 0.5$

$t = \frac{\sqrt{3}}{4} \text{ min}$

7. (c):  $R-\text{CH}_2-\text{CH}=\text{CH}_2 \xrightarrow[\text{CCl}_4]{\text{NBS}}$



8. (d)

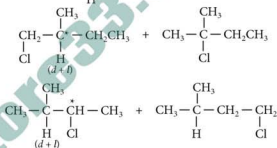
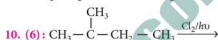
9. (4):  $\Lambda_m^\infty[\text{Cu}_2[\text{Fe}(\text{CN})_6]] = 2\lambda_m^\infty(\text{Cu}^{2+}) + \lambda_m^\infty[\text{Fe}(\text{CN})_6]^{4-}$   
 $= 2\Lambda_m^\infty(\text{CuSO}_4) + \Lambda_m^\infty[\text{K}_4\text{Fe}(\text{CN})_6] - 2\Lambda_m^\infty(\text{K}_2\text{SO}_4)$   
 $= 640 \text{ S cm}^2 \text{ mol}^{-1}$

$\Lambda_m^\infty = \frac{\kappa \times 1000}{s}$

$s = \frac{\kappa \times 1000}{\Lambda_m^\infty} = \frac{6.4 \times 10^{-6} \times 1000}{640} = 1 \times 10^{-5}$

$\therefore K_\phi = 4s^3 = 4 \times (1 \times 10^{-5})^3 = 4 \times 10^{-15}$

Comparing it with  $x \times 10^{-15}$  gives  $x = 4$



Total 6 isomers will be formed.



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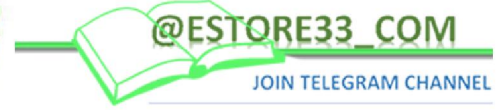
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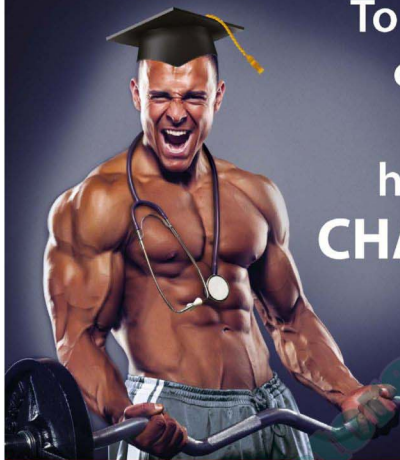
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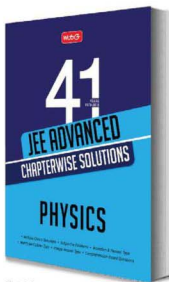
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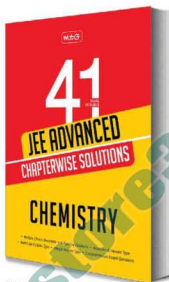


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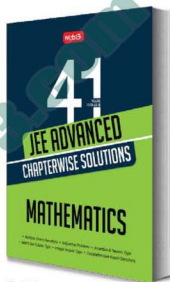
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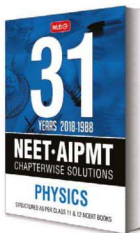
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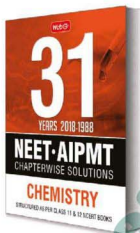


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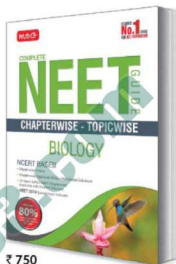
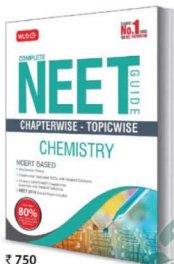
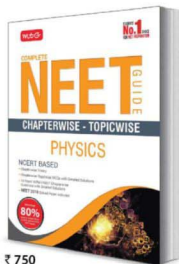


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